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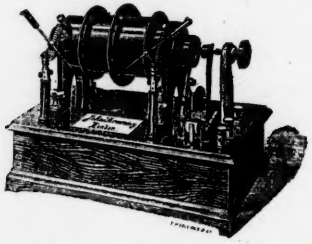

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THE

JOURNAL OF SCIENCE.

APRIL, 1880.

I. OUR FRIENDS AND HOW WE TREAT THEM.

ONE of the most unpleasant phenomena characteristic of the present age is the variety and number of minute but formidable enemies which assail us, either directly through our persons or indirectly through our means of support. Insects and Fungi seem to rival each other in the amount of depredation they can cause. We have, for instance, the *Oidium*, the *Phylloxera*, and the *Phona uvicola*, successively ravaging the vineyards of France, and bringing in their train distress and destitution. We have the redoubted Colorado beetle (*Doryphora*) taking a heavy percentage of the potato-crops of Canada and the United States, and the locust of the Rocky Mountains (*Caloptenus spretus*) widely destroying the harvests. We see the coffee-shrub withering away under the inroads of *Hemileia vastatrix*. Even useful insects, such as the silkworm and the honey-bee, succumb to parasitic diseases. Lastly, to complete this very brief sketch of minute plagues, we have flies which transfer from victim to victim the poison of disease, and make themselves the bearers certainly of carbuncle and of ophthalmia, and too probably of fever, cholera, and small-pox. There exist, we know, a certain class of writers who from time to time labour to prove, with an amount of sophistry which the most unscrupulous criminal advocate might envy, that all these scourges are blessings somewhat thickly disguised. Leaving these champions of nuisances to be dealt with by the broad common-sense of mankind, we may ask

why should such tiny pests, animal or vegetable, have become so much more prominent in our times than in the days of our forefathers?

Our first reply must amount to a partial denial of the alleged facts. Throughout history we can trace the existence of blights and mildews, and visitations of locusts, followed up in due course of famine. The point of distinction is that in our days any new depredator or *vastatrix* that makes its appearance is at once examined, described, and classified under a name which is safe not to err on the side of brevity. And whilst the *savants* are thus busy with their microscopes the ravages of the pest are duly chronicled in the press, discussed on 'Change in a hundred cities, and made the basis for speculative operations.

But there are veritable causes at work rendering it very probable that the evils in question may have seriously increased. The day of small things is over, whether for states, for manufacturing establishments, or for fields. We have vast areas of land, formerly occupied with a promiscuous vegetation, now covered with multitudes of one and the same species,—vines, coffee-trees, wheat, or potatoes, as the case may be. This is not without its meaning. Just as we can never have a widespread conflagration in a rural district where the houses stand far apart from each other, so epidemics do not arise where the species which they might attack, animal or vegetable, are few and far between, but rage more often and more severely just in proportion as such species become numerous and densely concentrated. This rule holds good with all classes of destroyers, from the jaguar and the wolf to the *Doryphora* and the *Phylloxera*, and even to those minute organisms which appear to be the causes of infectious diseases. They increase with their pabulum or their prey. Hence our modern agriculture has fostered its own enemies.

There is still a further cause for the spread of all such blights as are occasioned by insects. We have interfered with the balance of Nature, frequently destroying the very species whose especial task seems to be the repression of locusts and caterpillars, of gnats and carbuncle-flies (*mouches charbonneuses*). This task, as naturalists have again and again pointed out, though so far with very little effect, is mainly performed by the small soft-billed birds,—species which subsist almost exclusively upon an animal diet. It may be taken for granted that just in proportion as a bird feeds upon insects, rather than upon seeds or fruits, it must of necessity be harmless, and even beneficial to man. Yet

in spite of such considerations scarcely any class of animated beings have been so ruthlessly and wantonly persecuted.

Setting on one side, therefore, all other supposed causes of the increase of noxious vermin, and all proposed agencies for their destruction, it will not be useless to inquire into the growing scarcity of small birds in this country, and into its origin.

Foremost among the enemies of our feathered auxiliaries stands that unlovely being the bird-catcher or bird-fancier. His mission appears to be the sale of all such birds as possess anything attractive either in their plumage or in their song. He has a den—perhaps in the Seven Dials or in Whitechapel—where a number of unhappy goldfinches, linnets, larks, blackbirds, nightingales, and the like, are committed to close confinement until purchased by some man or boy of pseudo-ornithological propensities. As the captives are rarely supplied with proper food, or otherwise treated at all in accordance with their wants, their cage-life, if not merry, is at least short, and there is a brisk and constant demand for victims new. To ensnare these is one of the main points of the bird-fancier's craft. For this purpose he undertakes expeditions in all suburban districts, and is sometimes found as far as 50 miles out of town in search of his prey. He has his decoys and his lime-twigs, and his cunningly-devised "calls" for imitating the note of the species he hopes to entrap, and his success is unfortunately much greater than he deserves. His calling, be it remarked, is perfectly legal, except where he commits acts of trespass, carries off the eggs of pheasants and partridges, &c.—sins for which he has a very strong inclination.

Some years ago an Act was indeed duly passed by the Legislature for imposing a little wholesome and much-needed restraint upon the doings of this worthy. The disciples of the late Charles Waterton pleaded that, if these serviceable little creatures are to exist at all, a "close time" during the breeding season must be allowed them, just as in the perfectly similar case of game. During this time, if we rightly understand the provisions of the statute, neither shooting, snaring, nor nest-taking was to be permitted. Never has a parliamentary enactment proved such a dead letter. No one seeks or cares to enforce it. It is simply ignored. It so happens that at this very time, during which the snaring of birds is legally prohibited, and when it is especially fatal to the perpetuation of the species, their capture is particularly easy. Some of the victims sought for are birds of passage, and, if they enjoy immunity whilst nesting, the time during which

their capture in England is possible is greatly curtailed. Hence the interests of the bird-catcher are completely opposed to those of the birds and of the general public. Now the bird-catcher looks carefully after number one, whilst the birds go unprotected, on the good old principle that what is everybody's business is nobody's. Throughout the theoretical "close season" disreputable-looking lads and men, carrying upon their shoulders large, but evidently light, packages, discreetly covered with calico or baize, may be seen wending their way into the country in the early morning and returning at various times from 10 o'clock till noon. These raids are made by preference on Sunday mornings. If the observer goes a little farther afield he will see the covered cases unpacked and placed ready for action, whilst the operator crouches behind a bush or hedge to await the result. If successful the bird-catcher packs up his cages and returns home, walking calmly and fearlessly past the policeman on duty, who never wastes a glance upon him, as we have repeatedly witnessed. Perhaps the whole soul of the constable is concentrated upon that mystery the "*bona fide* traveller." Perhaps he knows nothing at all about the Act in question. Indeed, from "information which we have received," we suspect that this is too often the case. There being no associations, local or national, who make it their business to see the Act put in force, the attention of the police authorities is never called to the infractions which are daily going on. We cannot lay our hands upon a single instance of an offender being prosecuted. Our natural-history societies from time to time express their regret at the havoc which is taking place, and a few letters on the subject occasionally appear in the provincial papers and in some of the scientific journals; but there the matter ends. There is no regular concerted action, such as may be observed in many matters of much less importance. We demand such action. We are not aware whether the Royal Society for the Prevention of Cruelty to Animals can, in accordance with its constitution, here interfere, or whether its functions are limited to the protection of domestic animals. We have indeed stated the claims of our clients, the birds, merely from a utilitarian point of view, regarding them as the friends of the farmer and the gardener: but on the score of humanity the complete suppression of bird-catching during the nesting season is no less urgently called for. How many broods of young birds perish miserably of cold and hunger, whilst their parents are struggling and wailing in the cages of the bird-fancier, can scarcely be

conceived. It is plain that the majority of the birds trapped during the spring months must leave a nest in a state at least of partial orphanhood, and we must remember that to supply the young with food the constant labour of both parents is generally requisite.

The question then is, shall the Act for the preservation of birds not included in the game-list remain, as it now is, a mere impotent protest which the nation is too careless and indolent to put in force, or is it to be made a reality? The detection of the offenders would be ridiculously easy. They carry with them all the evidence needed for their own conviction. Cannot the police be got to examine these men when returning with their packages, and to take proceedings whenever they find traps, decoys, and captive birds during the close season? Could not country gentlemen see the propriety of putting their gamekeepers on the alert, especially as the bird-fancier, if not himself a poacher, is sure to be a friend and accomplice of poachers? Could not our natural-history societies take simultaneous action, at least in the shape of memorials to the local authorities, pointing out how completely the law is left in abeyance, and urgently calling for its enforcement? Might not the societies form in every district a nucleus round which the friends of humanity and the lovers of all that is beautiful in Nature might rally?

Then as regards the kindred evil of bird-nesting, how much more might be done for its suppression than now takes place! In France, where the extirpation of small birds has proceeded to a greater length than with us, and where a much larger amount of injury has been experienced in consequence both to property and persons, energetic attempts are now being made by the Government and the local authorities to lead the public, and especially the young, into a different course. "*Ne denichez pas*"—don't rob nests—is a maxim strenuously enforced upon the schoolboy. Lists of useful and harmless birds, reptiles, and insects have been drawn up by the Minister of Agriculture, under the advice of eminent naturalists, and posted up in every village,—and all such creatures the countryman is officially exhorted to spare and protect.

In America there are even State-naturalists whose duties are to ascertain what birds, insects, &c., are harmless and what are injurious, and to recommend the former for preservation. We do not see that any corresponding steps are being taken in England. We fear that in most of our schools in country districts, whether "board" or "denomi-

national," the children are allowed to remain in ignorance of the claims of the lower animals upon man. In many places—we may mention Aylesbury—the harmless newt is looked upon as a loathsome and venomous monster, which may be justifiably put to a death of torture. If one is found it is placed in any convenient little hollow of the ground, covered with petroleum, and then set on fire. Surely such ignorance is a national disgrace. We do not, indeed, recommend the appointment of "county naturalists." Such posts, if created, would be filled by poor helpless examinees who would be better acquainted with every subject than with zoology, and who in the field would be unable to distinguish a nightingale from a wagtail.

There is another cause which leads to the decrease, and must ultimately bring on the extirpation of many rare, curious, and beautiful species. This cause is peculiar to our country, and in the eyes of all foreigners it appears almost beyond the ridiculous. We refer to the "British" mania among the collectors of birds and insects. All scientific naturalists in these days, worthy of the name, consider the distribution of any living species on the surface of the globe as one of the most important points in its history. Consequently it is essential to know what species occur in every country, and even every district. But the mania in question is something quite different. Take, for instance, one of those butterfly-hunters who fancy themselves entomologists. He buys a cabinet, procures a set of printed labels of "British" species, fixes them duly in the drawers, and then endeavours to add to each label one or more specimens of each kind; this he effects by capture, exchange, or purchase. As regards the rarer forms, he is willing to pay the most preposterous price for a poor shabby specimen which has been—or is said to have been—captured within the United Kingdom, whilst he will scarcely accept as a gift one of the same species of avowedly Continental origin. Nothing of the kind, to our belief and knowledge, prevails in any other country. We have met with German collectors of insects exceedingly scrupulous as to the exact locality of every specimen admitted into their cabinets; but we never knew a higher price offered for a German specimen of any insect, *as* German, than if it had been taken in France, or Switzerland, or Hungary.

As regards birds the case is precisely analogous. The consequence is that as soon as a rarity is seen every marksman in the district is on the alert to bring it down and offer it for sale or exhibition as an authentic "British specimen."

Hence rare kinds are speedily blotted out, and others which probably have in former ages been inhabitants of our country, and which might re-establish themselves if left unmolested, have no chance of so doing.

The mania for British specimens tends, therefore, to impoverish the British fauna. We may here remark that of the birds shot and the insects captured, not one in a hundred serves for any truly scientific purpose. Many of them are simply wasted; many employed for barbaric decorations or worked up into uncouth devices. It is sad to see, in some cottage or country inn, a roller, or a bee-eater, or a hoopoe stuffed out of all approach to its natural shape, and to be told that it was killed in the neighbourhood. It is equally sad to read in the "Loamshire Herald" that a "rose-coloured pastor was seen several times last week, and was duly shot by Mr. Addlepate, of this town."

We loathe the bird-catcher and the bird's-nester, but we entertain quite as little affection for those who seek to destroy every beautiful species under the false pretext of "collecting." The true naturalist, whatever be his favourite department, is chary of animal life, and kills no specimens save the few required for determination, for dissection, or for experiment.

There is yet another agency, quiet but effectual, by which the numbers of our insect-eating birds have been thinned. We refer to the agricultural reform, so-called, which reduces our fences to a mere nominal line of stumps, or replaces them with wire; which seeks to abolish hedge-row trees, and lays small plots of land together into one huge field. We know that a certain amount of soil is thus economised, but there is the other side of the account to be considered. These very improvements deprive the birds of cover for their nests, and compel them to go elsewhere. The natural consequence is that the caterpillars, the aphides, the weevils, *Halticæ*, and the like, in these model fields are not sought for and destroyed. If we require evidence for this assertion it may be found in the fact that where hedge-rows and scattered trees are wanting, as in most parts of France and Spain, or where wire fences and railings are used in their stead, as in the Western States of America, there the damage from vermin is greatest. Then man—with Paris green, and fire, and traps, and cunningly-devised sweeping-machines—strives, at great expense and trouble, to undo the mischief which has sprung from his own short-sighted greediness.

We have referred to the waste of birds and insects for

personal decoration, as fashion now sanctions. This folly, for we can give it no milder name, has little effect upon our native species, though we have heard, on apparently good authority, that a lady once wore at a ball a dress trimmed with the skins of a multitude of redbreasts. But we greatly fear that not a few rare and magnificent natives of tropical regions are doomed to extirpation in virtue of this very whim. We should recommend a law prohibiting, under very stringent penalties, the use of any humming-bird, sun-bird, trogon, or bird of Paradise, or any part or appendage of such bird, as ornaments or accessories of human attire, or their sale by any plumassier or milliner. Such an enactment would not be, as some persons imagine, a "sumptuary" law, since its object would be to restrict not luxury, but the wanton slaughter of beautiful, harmless, and in many cases useful creatures. We do not think that there is any present hope of such a measure being even introduced into Parliament, but it is our duty to point out its imperative necessity.

II. ORGANIC SYNTHESIS AND ITS SOCIAL BEARINGS.

NATURE, if we may use the expression, places before man not a few dilemmas which are scarcely perceived in his earlier career, but which are painfully felt in proportion as population thickens and civilisation advances. Of these, one of the foremost relates to the prime necessaries of life and their production. If bread, meat, butter, vegetables are to be had at a low price, the farmer and the grazier complain that their business is unremunerative, and can only be carried on at a loss. If the same articles are dear, the trading and manufacturing classes suffer. Hence we find that a season of general plenty is not regarded by the cultivator of the soil as an unmixed blessing. If his crops are greatly increased their money-value will fall in proportion, and the main result of the bountiful harvest will be, as far as the farmer is concerned, more work for the same profit. Hence we find, in various departments of the food-

trade, that prices are systematically kept up by the intentional waste of a portion of the available supplies. This is notoriously the case, as far as England is concerned, with fish. Those who rule the trade prefer to sell 50 tons at 6d. per lb. in place of 100 tons at 3d., and with an article so perishable they find little difficulty in carrying out their schemes. A great misfortune is that whilst in the manufacture of hardware, or of textile and fictile goods, the progress of invention has increased the profits of the producer, nothing similar holds good in the growth of food. Strange as it may sound, the rudest agriculture is relatively the most lucrative. If a man roughly breaks up a fruitful piece of ground, scatters seed over it, and, without troubling himself much with its after-nurture, gathers in the crop, his gross produce is almost exclusively net profit. But if he is obliged to expend a large amount of labour, and to employ costly appliances, mechanical and chemical, though his gross returns are very much larger than those of his rude forerunner, his percentage of profit is necessarily much lower, and he may be driven—as are many English farmers of the present day—to reflect whether his capital might not be more usefully invested. To this comes the further fact that the agriculturist is exceptionally exposed to unforeseen disasters from the seasons. Hence we find, in brief, that the interests of the food-producer and of the food-consumer are in antagonism. The question arises which of these two bodies is to be sacrificed to the other? This question has now been debated in England for many years, to the great glorification of the speech-makers, statesmen, agitators, and economists of high or low degree. Extensions of franchise, protection, free trade, trades-unionism have been prescribed and tried, but none of them has healed the disease. Is it, then, too much to hope that John Bull may begin to look for help in a quite different quarter, like the piper's cow?

> "The coo considered wi' hersel'
> That wind wad never fill her."

May we not look for relief to inventors and discoverers rather than to orators?

We use for our support plants and animals. We eat such beings either entirely or in portions, or we extract from them by mechanical and chemical processes certain substances needful for our maintenance. Why do we make use of their intervention? Simply because we cannot derive nourishment in a direct manner from the soil, from the air, and the

water. Our food must consist of matter in certain organic combinations; and though we can find the single ingredients of such combinations in minerals, in the air, and in water, we cannot assimilate them and make them part and parcel of our tissues. But this task, which is impossible for our bodily organs, plants effect with ease. They create nothing, but they put together the elements which they obtain from the dead matter around them, and form fruits, roots, leaves, &c., which we can eat, digest, assimilate, and be thereby nourished. The animals which serve us for food support themselves mainly upon plants, and do little more than concentrate the nutritious matter found therein, and render it perhaps more easily assimilated. Their part is therefore of secondary importance, and need not further engage our attention.

Let us now take as one of the simplest cases a useful plant—the sugar-cane—and enquire what is the service which it renders to mankind? Simply this: it takes the three well-known and plentiful elements, carbon, hydrogen, and oxygen, and combines them together in such proportions and with such an arrangement of particles as to constitute sugar. Every cane, therefore, is a workshop in which sugar is produced, and all that remains for man to effect is to separate out the sugar, which in Nature exists dissolved in the juices of the plant, and preserve it in a state of purity ready for use. But let us now suppose that we could take these same three elements—carbon, oxygen, and hydrogen—as they exist in air and water, and combine them together in the right proportions, thus forming sugar by the synthesis—the putting together—of its ultimate materials. We should thus dispense with the soil required for the growth of the crop; with the manure for its fertilisation; with the labour needed for planting, tending, and reaping the canes; with the plant and machinery used for the extraction of the sugar, and with the attending waste; and lastly, but not least, with the time which now elapses from first planting the cane to the day when the sugar is ready for the market, and with the interest on the capital sunk. Add that the supply of sugar would be henceforth quite independent of hurricanes, floods, plagues of rats and termites, and all the various contingencies, living or lifeless, which now from time to time blast the hopes of the planter. The consequence would surely be a benefit to all parties concerned, greater profit to the producer, and easier prices to the consumer.

Let us now suppose other articles of food generated in a

similar manner from lifeless matter. Surely in such a case the anxiety of life would be lessened, and the margin between every man and actual want would become indefinitely wider than at present. Should we not here have a "reform" wider, deeper, and more satisfactory than statesmen of any school ever dream of?

But when suggestions of this kind are laid before the public it must not be assumed that they meet with universal approbation. A friend of ours once broached, in a mixed company the notion of the synthetic production of food. A reverend gentlemen present gazed on him with a look of horror, and said he little thought he should ever have "lived to hear such an awfully wicked and blasphemous proposal." On this outcry no comment is needed. It is merely a repetition of the opposition with which the lightning-conductor, the discovery of vaccination, and the use of anæsthetics were greeted. It is strange, however, that "ministers of all denominations" never reflect how by such opposition they play into the hands of the so-called "free-thought" party.

Another note of opposition is raised by some who affect to speak as the representatives of the working man, probably by the same right that the ichneumon might represent the caterpillar. They denounce us indignantly for seeking to feed the poor on "drugs and chemicals." Their eloquence, being solely the outcome of their ignorance, needs no refutation. Still we may show that this kind of opposition is in part to be traced to the circumstance that not a few of the outside public confound the proposal which we are making with certain fraudulent and semi-fraudulent practices which now play but too prominent a part in the production and sale of food. Time was--at least so it is charitably supposed—when our articles of food and drink were all what they professed to be; when bread was made from the powder of wheat, with no other additions than water, salt, and yeast; when wine was the fermented juice of the grape; when milk was a secretion of the cow, and butter a constituent separated from such milk. In virtue of that very food dilemma of which we spoke at the outset, this is no longer the case. Butter, or at least what is commonly sold as such, may consist of lard, tallow, rape oil, and the like. But synthetical butter, such as we suggest, will be made not from the fat of any animal or vegetable, but from the very same fats which exist in natural butter, prepared from inorganic materials. The possibility of the presence of any morbid or infectious matter would thus be excluded. Between artificial food and adulterated food there can be no analogy.

From a third quarter come sceptical voices of a more intelligent and matter-of-fact nature. Say they:—All this is very well to propose, and would doubtless prove exceedingly useful if carried out, but what is the prospect of its ever becoming a practical reality? Can sugar, or any other article of food, be produced artificially from its inorganic elements? So far, we must certainly admit that this triumph has not been achieved. But we must keep it clearly in mind that chemists are, it might almost be said day by day, learning how to prepare artificially substances which a little time ago were obtainable only through the intervention of animal or vegetable life. There is in particular one instance so significant and instructive that, though the facts of the case are perfectly well known to all students of chemistry, we cannot refuse it a brief notice. From time almost immemorial a certain substance, now known under the name of alizarin, has been employed for producing exceedingly fast and beautiful colours upon cotton and other vegetable materials. Till within a few years this dye was only obtainable from certain plants, and above all others from madder, which on this account was very extensively cultivated in the neighbourhood of Avignon, in Alsace, and Zealand. There is, we may remark in passing, reason to believe that it was formerly grown to a considerable extent in Norfolk. It is certain that a street in Norwich retains to this day the name of the "Madder Market." Latterly, however, chemical research pointed out the way of preparing it artificially from some of the constituents of coal-tar. At first this artificial alizarin was a mere curiosity, but gradually the process for its preparation has been simplified and rendered cheaper, until at last cotton goods can be dyed a Turkey-red with this manufactured product at less expense than with the root of the madder-plant, and the cultivation of the latter is therefore now substantially a mere matter of history. Now we must especially beg the non-chemical reader to bear in mind that this artificial alizarin is not a substitute for, or an imitation of, the natural article, as is, for instance, "butterine" of butter. It is in every one of its properties, physical and chemical, identical with the product of the madder-plant. Place a sample of pure alizarin in the hands of the most able chemical analyst, and he will be unable to tell whether it has been obtained from coal-tar or from the plant. Hand the same sample over to the practical dyer or calico-printer, and he also is at a loss.

There is, however, an objection which may here be urged. This same alizarin is also composed of the three elements,

carbon, oxygen, and hydrogen, though in very different proportions and in a very different arrangement from what we find in sugar. But we do not form it artificially from these elements as they occur in a free state, or in mineral compounds, but from coal-tar. Now coal is well known to be the residuum of vegetable matter, so that our artificial alizarin is, after all, a plant-product, like that obtained from the madder-root.

To this objection it may be replied that alizarin, like all the coal-tar colours, can be obtained from the mineral oils of the Caucasus, and these—according to no less an authority than Prof. Mendelejef—are derived not from the decomposition of any animal or vegetable remains, but from the reactions of purely mineral matter, in which graphite—a form of inorganic carbon—is supposed to have played a leading part. Hence, then, alizarin obtained from the refuse of the petroleum of the Caspian would be in its origin quite independent of organic life.

There is another quite recent instance of the artificial preparation of a so-called organic body which is free from all objections, though its utility as yet is but limited. Formic acid was at one time regarded as a secretion of certain ants, beetles, and other insects, and as obtainable only through their mediation. Then a method was discovered of preparing it artificially by distilling vegetable substances, such as tartaric acid, with oxidising agents. Here, however, we are still employing organic matter, and a final step was still wanting. This has now been taken: it is found that if the gas formerly known as carbonic oxide, but now termed carbon monoxide, is passed over a mixture of caustic soda and lime with certain precautions, formic acid is generated in such abundance that if required it would be available for industrial purposes. Now, as carbon monoxide is not merely an inorganic compound, but can be prepared without employing any ingredient of organic origin, the problem is solved, and the animal compound, formic acid, is obtained synthetically from inorganic matter.

In face of such facts there is, we submit, no reason to set aside the notion of the synthesis of food-products as chimerical. It will very probably be found a long and difficult task, but in consideration of its paramount importance men of science will not be justified in despairing.

There is, however, one limitation to which especial attention must be drawn. The useful bodies which we obtain from the animal and vegetable kingdoms may be very naturally divided into two great classes. On the one hand, there

are so-called chemical individuals—such as sugar, starch, tartaric acid, glycerin, gelatin, albumen, and many more. On the other, there are organised bodies, possessing a definite structure, and composed of a mixture of two or more of the chemical individuals aforesaid. Now there is no *à priori* reason why we should not ultimately be able to produce artificially any and every chemical individual which Nature affords. But there is no reason to expect that we can ever succeed in forming even the simplest part of any plant or animal. Thus we may hope to form artificially albumen, with all its natural properties, and to use it as a valuable article of diet, but it will never be in our power to manufacture an egg. We may make the sugar, the tartaric acid, and every other compound found in a grape, and by combining these in the right proportions we may obtain a sum-total which shall have the taste, the smell, and the physiological action of a grape, but we can never give it the structure of a grape.

Here, then, is a rubicon which we can never cross so long as Life approves itself a something distinct from heat, light, electricity, and all the other phases of force or energy.

III. INSTINCT AND MIND.

By S. Billing.

THE question whether the character of mind found in animals and that displayed by man is the same, both in its bases and characteristics, appears to be generally interesting; and it must be admitted that with the scientific and the *quasi* scientific the greater number incline to the idea that between them there is no specific difference. I will attempt to show not only that there is a specific difference, but that mind *in its true significance* has no place with the animal: to go further, if man were but an animal it would have no place with him. Elsewhere I have contended* that man is an animal and something more, for he has a character of intelligence which as an abstract metaphysic may be inferred to be the *soul*, and herein is the

* Scientific Materialism and Ultimate Conception.

essential difference between man and the lower animals. It appears to me that the true distinction between animal instinctives—great as they are—and mental power is lost sight of, or not understood or ignored, by the many narrators of pretty instances of animal sagacity, and by those sages who insist as a scientific dogma that instinct and mind are common to animals and to man.

In my work I have treated the subject in a discursive and fragmentary manner: the distinctions appeared so marked and decisive that I refrained from giving the subject a special chapter; the incidental observations seemed to me conclusive of the subject, and were really interfused for the purpose of showing the fallacy of the materialism so broadly interpolated in many scientific memoirs. I am impressed with astonishment to find some of our greatest biologists and so-called metaphysicians insisting on a mentality (if it be one) wholly due to sensory impressions as synonymous with the reasoning faculty of cultured man. How this arises it is difficult to understand, for the reasoning on the subject appears to be wanting in those characters of induction and deduction so necessary in the discrimination of scientific theses, and also in that analytical acumen which alone can be determinative of the problem.

I begin my special observations by an admission so large in character that some may consider it as conclusive of the question. I concede as animal instinctives, consciousness, association, appreciation, comparison, contrivance, constructiveness, will, and memory, and all the inferences appertaining to these faculties which have their bases in the senses. All of them are powers which are necessary for the enjoyment of animal existence, and are displayed in the many amusing and instructive anecdotes of animal life. When I shall speak of insect life the instinctive capacity amounts to a *prevision*, this prevision greatly exceeding the instinctives appertaining to the more highly constituted animals, not excluding man. I mean by a prevision the power which some insects possess of foreseeing conditions necessary to the preservation and to the perpetuation of the particular species. It cannot be argued that this faculty could have arisen from any process of reasoning, it having relation to acts of which the parents could not be cognizant) as in the majority of the instances the parents have no experience to direct them, they having ceased to exist before their progeny has being. It is therefore an innate and hereditary instinct, and has application to the particular varieties of insect life.

The characteristic of mental power is that of an individualism: there is no individualism in the animal instincts, however much there may be of character. The argument would be equally imperative even if cultured man was eliminated. Savage man has abstract ideas of the equities, —*i.e.*, the particular relations of man to man, a sense of justice which controls his innate sensuous propensities; and has besides a conscience, of which, in its true abstract consideration, there is no instance in animals. It would seem, the fact that no animal has been discovered which is a fire-raiser or a fire-preserver should settle the distinction between instinct and mind. Monkeys will assemble around a fire in the woods left by a hunter or wayfarer, but there is no record of their ever having added a stick to the fire, imitators as they are, in order to continue the warmth they so much affect; even the anthropomorphous apes, which our *savants* mark out as the immediate ancestors of man, must be included. The preservation of the fire, the connection of the sticks with the warmth, is a reasoning process to which they have not attained. Surely, if the animal mentality and that of man were the same, the isolation in respect of fire would not have continued for the hundreds of thousands of years through which fire has been the familiar implement of man, and which he has possessed, if geological evidences are to be admitted, before the pre-glacial period. Geikie and his companion, in the pre-glacial boulder clay at Brandon, in Suffolk, found charred sticks and flint implements.

In examining the question of Instinct and Mind it is necessary to define the meaning intended to be conveyed when the words are used. Instincts are inherited faculties appertaining in particular degrees to all animal organisms, and have their origin in the senses, and their enjoyment in sensuous gratification and in the perpetuation and preservation of their species. All mentalities which are said to pertain to animals have their expression in sensuous aptitudes, and are directed to the gratification of the selfish instincts. If the various anecdotes denoting animal mentality are thoroughly examined they will all be found directed to some sense gratification, and that when the animals subject them to control it arises from the memory of some former discipline. The study of biological history proves that the animal instincts are graduated in accordance with the necessities of existence: this can be traced throughout the range of animation commencing with the protamœba, whose only instinctive faculty appears to be directed to

nutrition and to perpetuation. To go beyond the protamœba to the blood corpuscules, unless they are considered to be amœbas, we have a collective community possessing no independent life. Dumas, when experimenting on the blood corpuscules after the method of Berzelius and Müller, found they were subject to decomposition, but which he obviated in filtration by passing a current of air through the liquid, thus renewing the condition in which they exist in arterial blood. This would seem to show that they have respiration, and it has been shown they are propagated by fission. If they change their forms, and breathe, they have animation, but to them cannot be conceded those conditions named instincts. From the blood corpuscules, supposing an independent animation up to and including man, we have graduated instinctive aptitudes exactly apportioned to the place in Nature which each animated variation holds. If we are to argue that the manifestation of particular instincts in particular animals shows mind, it may be claimed for plants,—*e.g.*, the *Valisneria spiralis*. The female flowers float on the surface of the water; the male plant is chained to the bottom: when the period for fecundation arises, the peduncles of the male flowers break, mount to the surface, and float around the female flowers, whereby fecundation is effected. The *Utricularia* has even a more interesting process. These plant facts are quite as extraordinary as any instances of mental aptitudes recorded of animals. The plants manifest desire, purpose, and will, and the instances go to prove that creation or animation—which you will—is an extended chain with innumerable links. Regarding man in his animal nature, there appears to be no distinction between him and the higher order of animals in the gratification of the instincts of his nature, excepting so far as the sensory selfism is directed by a higher order of instinctive adaptability.

When we define mind we define a higher power than instinctive aptitudes; call it intelligence, we will not pause for a word: it is that power which enables man to conceive ideas, and to reason on subjects which in no wise are included in the category of the senses, or have their bases in them—abstract ideas, the true use of which is to subject the animal selfishness, the outbirth of the sensory instincts, to the power of these abstractions, whereby an equitable relation is instituted between man and man and between him and the lower creations, his being is elevated, and his brute instincts subjected to reason. It does not follow because man rarely reduces these equities into practice that therefore

they do not exist. I do not care to enter upon abstract questions of religious belief, although in some form they have their phase in the minds of all men, and therefore speak of social equities. It is obvious the higher the mental abstractions are carried, the farther mind is removed from instinct.

As I define instinct or animal mentality, it is directed to sensuous gratification, and has its bases in the senses, and thence result emotions and the simulation of reasoning. Intelligence is the concentration of all mental aptitudes in which arise abstract principles leading to the contemplation of ideal sentiments and sympathies, teaching the exact relation of thing with thing, not only discerning phenomena, but ascertaining their origin and bases, and, by a parallelism of principles, adducing mathematical precision and metaphysical exaltations. The ice fades from the view; it is a sense perception of the phenomenon, but the cause of its fading is ascertained by a mental abstraction; thus we should say we perceive effects, but by mind we find their causes, and conclude the distinctive powers of the mind have higher bases than sense gratifications and sense emotions.

There is another distinction between Instinct and Mind which in the consideration is most important; even if it does not conclude the argument, it marks the line of demarcation so broadly that it becomes difficult to imagine how the boundary is to be passed. This I call the *tribal.* On consideration it will be found that any peculiar characteristic observed in creatures,—whether it be of a class, genus, species, or variety,—that each member of the particular denomination, be it genus, species, or variety, is possessed by the communal tribe as an innate inherited power. If we take dogs, the species is divided into varieties or the genus into species; whether the proper phrase be species or variety, each has its peculiar distinction—thus, the pointer, the gazehound, the shepherd's dog, the retriever, &c. The aptitude of each is tribal; the gazehound has not the instinct of the pointer, or the shepherd's dog that of the retriever, &c. Each variety has the aptitude of the instinct without instruction. Whenever tricks are taught to animals the means are either the incitation of appetite or the infliction of pain, the memory of which keeps the creature steadfast to its teaching, until it becomes as it were ingrafted into its nature. The tribal characteristic is found in the habits of wild animals; particular species of birds have the same constructive instinct, and varieties of the same species differ in the constructive

faculty; and whenever a variation occurs in a particular species or variety, each member of its class practises the same peculiarities. In some rare cases are found adaptabilities to particular circumstances: not to multiply instances may be noted the jackdaw which built its nest in the window-ledge of a tower, and piled up sticks to make the basis of its nest more stable. The constructive instinct of birds is most diversive in character, but the tribal character is always maintained. It is the same when the *prevision* of insects is noticed: the water-spider (Naiadeæ) weaves a water-tight cone beneath the water, attaching it to the bottom with stays of silk, in order to provide a shelter for its young. Its labour would be useless unless the creature could empty the cone of the water with which it is filled. Walcknaer, who critically observed their habits, says they fix a globule of air to a hair of their bodies, and descend with it to the nest and eject it beneath the cone, by which means they force back the water, and fill it with "respirable gas." "The spider comes to the surface of the stream, takes a bubble of air under its abdomen," and carries it beneath the water: the voyages are repeated till the bell is completely filled with air. Thus we may say Nature invented the diving-bell; but man, the copyist, has not equalled the inventor: the insect begins and completes its dwelling below the water, and afterwards expels the water, replacing it with air. In all animal mechanics the principle is the same; it is the whole tribe or species which possess and practice the aptitude to which culture could not add; the instinct is the inheritance of the particular tribe or variety. In all this there is no individualism; we find only a class distinction. The sassafras bombyx deposits its eggs on the leaf of the tree, and then interweaves the leaf-stalk with the stem of the tree so strongly that the leaf, laden with its living freight, remains on the tree, braving the blasts of the winter. This process could be conceived to be a reasoned abstraction (although related to the affectional instinct), but the same fatality as an adverse argument exists—the distinction is tribal. The larva of the ant-lion in dry fine sand hollows a funnel-like inverted cone, and makes the slopes so regular, and at such an inclination, that they cannot be climbed: the larva buries itself at the bottom of the trap; an insect stumbling on the edge of the pit falls into it; the yielding sand carries it to the foe in waiting, and, more, the creature ejects from its lair the *débris* of its feasts,—using its head by way of a catapult, it launches the refuse far from the snare: still the instinct is

tribal. Some ichneumons, or *vibrating flies*, pierce the outer skin of a caterpillar and insert their eggs beneath it; when hatched the larvæ distinguish between the fat and the vital integuments, and it is only at the close of their existence they assail the vital organs, and then issue through the openings in the skin, and spin their cocoons on the surface of the corpse which had been their home and their aliment. In these instances—thousands more could be adduced—there appears to be a working and applied intelligence, and if they were the result of culture could not be distinguished from reason. But in these cases of prevision, as with other inherited characteristics, they are innate and tribal.

The illustrations above adduced are so broad and distinctive as should suffice to exclude the idea that animal mentality and mind, as presented by man, are the same. The first has its base in the senses, and is common to the species or varieties by which it is exhibited, *i.e.*, tribal. In man's mentality there is an individualisation. The insect and the animal gets from its tribal instinct that which the races of man acquire by culture, and in the beyond of the sense mentality man has the abstract and the ideal.

There are doubtless many extraordinary tales told of the doings of animals, but on a careful analysis they may all be traced to affectional emotions and to sensory impulses; many probably are unintentional exaggerations arising from imperfect observations, and are sometimes amplified by the astonishment excited by what appears an unusual incident. I could tell extraordinary tales of my dog Grip, as could other possessors of dogs; but in all the peculiarities there is always a something wanting—that missing link which shows the distinction between mind and instinctive adaptability.

I have endeavoured comprehensively to treat this most interesting subject, avoiding the introduction of anything extraneous into the argument. To me the problem appeared to be a simple one; but when I find a great diversity of opinion enveloping it, and ponderous tomes presented assuming to be analyses of mind and instinct, I pause in wonder. The works, for the most part, are confined to anecdotes of animals, amusing, but very vague when used as the bases for argument.

In reviewing the subject I cannot but feel that irrelevant and ill-digested comments have built up an argument which appears to be wanting in a fundamental principle. In the diorama of the universe the most modest of inorganic

products, the merest speck of animation, through its cycle by development, reaches up to man. Each plays its part in the grand Kosmic picture: each is an adjunct in one grand scheme; the inorganic is succeeded by the organic, so instinctive capacity is succeeded by mental power, for some comprehensive end, although its purpose may be concealed from our purview. Had there not been a purpose to be accomplished, other than merely the successions or mutations of the inorganic and the organic, Mind becomes a needless feature in the grand panorama; but as there are no wastes in Nature, we must conceive Mind in the vast projection of creation plays its part as a distinctive capacity, or we must conceive its institution to be but a wasted energy. This is inconceivable, for each part in the Kosmic idea has its place; and impossible, for if intelligence designed, intelligence completed its project. The Kosmos discloses a tremendous mechanism, diversified yet homogeneous; and as in the march of events we find that there are no mechanisms but which owe their institution to intelligence, we then can view the universe as the condensation of a thought—the material presentment of an immaterial energy.

IV. MODERN ADVANCES IN METEOROLOGY.

NONE of the Sciences, save perhaps Electricity, has taken such rapid strides during the last fifty years as the much-despised science of Meteorology. Strange to say the advance of the one has been closely bound up with the progress of the other in a much more intimate manner than the casual observer would suspect. For the greatest advances in electrical science have been the result of the improved methods of measuring electrical quantities which were necessitated by the growth of the telegraph; and the modern advances which have been made in meteorological science consist of deductions drawn from observations simultaneously made over large areas, and transmitted by telegraph to central stations. The entire modern system of storm-warmings—whether we refer to those issued by our own Meteorological Office, or to the

predictions of "Old Bob" out in the Far West—dates from the era when the preparation of daily weather-charts was rendered possible by the use of telegraphic signals. To a large section of the public, however, the process by which these deductions and predictions are arrived at is a complete mystery. They hear of cyclones and anti-cyclones, and areas of depression travelling over land or sea, and think that the invisible and intangible entities thus described are something quite beyond their comprehension. While it seems wonderful enough that Captain Saxby can predict a high tide in the Thames, or the American meteorologists "cable" us a storm-warning two or three days in advance, the occasional failure of a prediction or the unexpected and unannounced advent of a storm continues to puzzle the good folk, who once more take refuge in the notion that the governance of the weather has not yet been entirely handed over to the calculators, who must therefore be regarded as only one degree more entitled to respect in their predictions than are Zadkiel and Old Moore.

Very wisely, therefore, it was determined some months ago, by the Council of the Meteorological Society, to arrange for the delivery of a course of popular lectures by some of the most accomplished of modern meteorologists, who should, as it were, take the public into their confidence as to the method in which the observations of the weather are made all the world over, and how these records can be *used* for the benefit of mankind. These lectures have recently been published in a handy little volume entitled "Modern Meteorology."* Anyone desiring to possess, in simple language and accessible form, an accurate and reliable account of the modern methods of weather-lore, cannot fail to be pleased with this little work.

The first two lectures of the series are of an introductory character, and deal with the Physical Properties of the Atmosphere, and with the Range and Distribution of Temperatures in the Air: they are by Dr. R. J. Mann and Mr. J. K. Laughton respectively. Admirably do they set forth the necessary bases of observation of climate and weather. The nature and composition of air, its compressibility, its expansion by heat, its weight and pressure, are all dealt with in turn, and the relation of the invisible water-vapour it contains to the production of mist and rain explained. The question of the temperature of the air at different

* Modern Meteorology: a Series of Six Lectures delivered under the auspices of the Meteorological Society. (London: Edward Stanford. 1879.)

points of the globe is treated of with equal clearness, and the causes that tend to modify it are set forth. The influence of exposure in promoting rapid and extreme changes of temperature, and, on the other hand, of shelter from radiation in hindering such extreme changes of climate, are commented on ; and it is shown how we may explain one of the marvels of Arctic voyagers, who have frequently observed the intense heat of the direct sunshine blistering black paint, and making the pitch boil and bubble up in the seams of the ship's deck, whilst all around the snow lies thick over the frozen earth, and the temperature in the shade is many degrees below freezing-point. Our old friend the Gulf Stream, and the service it performs in carrying heat across the ocean, thereby rendering habitable these islands, which would otherwise be as inhospitable as Labrador, claims attention as being but one of a very large number of similar ocean-currents, all performing the same great function of equalising extremes of temperature and softening down the otherwise unendurable rigours of torrid and arctic climates. The account given of the warm and dry winds often experienced on the lee-side of a mountain, or range mountains, is extremely instructive.

The third lecture, on the Barometer and its Uses, is by Mr. R. Strachan. Some of Mr. Strachan's remarks anent the popular notions concerning the predicting power of the weatherglass are so excellent that we quote them piecemeal.

"The barometer has always been vaunted as a weather oracle, but it really has no pretences to such a dignity. It simply shows the statical pressure of the atmosphere above it. This pressure must change before there can be any variation of the barometer, supposing of course that it is kept in the same temperature. The air puts the mercury in motion; hence inertia and friction must cause the column to change *after, not with, certainly not before*, the air pressure varies. If it be admitted that every wind has its weather, then to observe the direction and the force of the wind is the first step to observe the weather. Now the wind is a dynamical condition of the air, one which we are accustomed to roughly estimate from our sensation, and it is very advantageous to have in addition an exact measure of the statical condition of the air at the same time, which the barometer gives us. We gauge then not only the horizontal movement of the air, but its vertical mass as well, and with the two estimates we are better enabled to judge of proximate changes than with either alone. However, the practice

has been, for the most part, to relate changes of wind and weather to the state of the barometer; and innumerable rules have been propounded to enable everyone to become weather-wise by the aid of a barometer. . . . A sort of elixir of them has been distilled and bottled up on the barometer scale, to satisfy the craving for condensation, for knowledge formulated—in short for Science, which humanity manifests. I refer to the lettering on the scale, with which we are all familiar, which, however little objectionable in cities like London and Paris, when it got abroad among the hills and mountains in the interior of continents, and away on oceans, appeared sometimes grotesque, not to say absurd."

Now the great advance from these untrustworthy guesses from solitary observations arose from the systematic observation over large areas. Such observations revealed that over a storm area the atmospheric pressure was distributed in a singular and symmetrical way; that while all great storms and tempests whirl round a calm centre or nucleus, this nucleus, or "eye" of the cyclone, has the lowest barometer, while the pressure increases all around in widening circles to the outmost regions of the storm. Moreover, it is known that in the northern hemisphere all such storms rotate round the centre of depression in the opposite direction to the hands of a watch. The relation to these cyclones of certain centres of greater barometric pressure, or anti-cyclones, which usually bring fine weather, and around which the winds sweep in an opposite direction, is carefully explained.

One other quotation we must make from this excellent lecture, respecting the well-known hypothesis of a connexion between the cycles of sun spots and the cycles of weather and storms:—

"As regards annual values of barometrical observations, no periodicity has yet been traced for them. They appear to me to afford the most precise data for investigating the sun-spot cycle as connected with weather. There are no *à priori* reasons known to me for supporting that theory, and I consider the great amount of labour expended in bolstering it up as very much misapplied, and the whole thing as a wild-goose chase, on such paths as the rainfall, the black-bulb thermometers, and auroræ. Only I would remark that if it be proved that the sun-spot maximum coincides with a barometer minimum, and the sun-spot minimum with a barometer maximum in India, there must be some region or regions where the law is reversed, otherwise we should have

to acccount for an abstraction from our atmosphere in some years, and an accession to it in others."

The fourth lecture, on Clouds and Weather-signs, by the Rev. W. Clement Ley, is a most readable and lively chapter, and its value is enhanced by a beautifully coloured plate. We do not remember any published work which gives with such admirable clearness an account of the relation subsisting between different kinds of cloud and the lines of barometric pressure and of cyclonic movement. The description in particular of the "anti-cyclonic stratus" frequent during a spell of fine weather in winter, and often accompanied by dense ground fogs, is extremely interesting and valuable.

The lecture on Rain, Snow, Hail, and Atmospheric Electricity, by Mr. G. J. Symons, is a clear summary of the most recent information on these heads, while Mr. R. H. Scott, of the Meteorological Office, sums up the whole matter with a discourse on the Methods and Objects of Meteorology, showing why a scientific knowledge of the weather is sought, and what incalculable value it will be to mankind. To every profession and calling of mankind, to the farmer, the cotton-grower, the sugar-maker, the soldier, and the physician, the power of foreseeing and foreknowing the conditions of time and climate for a few months or weeks ahead would be of priceless moment. The skein to be unravelled is truly a tangled one, but thread by thread it is being tracked out and unfolded. But three centuries ago the advent of comets and the occurrence of unusually high tides were regarded as phenomena outside the realm of exact knowledge, and as defying all calculation. Science, which steadily lays hold of the uncorrelated facts of Nature and marshals them into ordered symmetry, has long ago conquered the comets and the tides, and has even taken in hand the star-showers. Who shall doubt her power also to seize upon the laws of wind and weather, tracking them to their hidden sources, and making them her own. The modern meteorologist is of this faith, and works patiently to this end. With Newton he believes that "the whole difficulty of philosophy seems to me to lie in investigating the forces of Nature from the phenomena of motion, and in demonstrating that from these forces other phenomena will ensue." And with Newton he can add—"I would that *all* other natural phenomena might similarly be deduced from mechanical principles."

IV. THE RATE OF ANIMAL DEVELOPMENT.

By J. W. SLATER.

"Consider young ducks."

ONE of the attempts which have been made to establish the existence of a "great gulf" between man and beast may be pronounced exceptionally curious as an instance alike of careless and defective observation and of rash conclusions. That by such arguments men of eminence could really mislead themselves, and succeed for a length of time in misleading the outside public, is deeply humiliating. Prof. St. George Mivart suggests* that a book should be written on the "stupidity of animals." We are far from denying that such a work would be useful; but should the needful companion volume on the "stupidity of man" make its appearance in due course, it might not unfittingly open with the reasoning we are about to quote.

To begin then: the slow bodily development of the human infant and its prolonged helplessness are matters far too familiar to require proof, or even illustration. No less familiar and universally admitted is the rapidity with which foals, calves, lambs, kids, chickens, and ducklings acquire the use of their limbs and other organs. These facts could not fail to come under the notice even of the most careless observers. But who could have imagined that the said facts would be, without further enquiry, at once seized hold of as a theme for stilted declamation, and be elevated to the rank of a fundamental distinction between man and the lower animals. Yet this strange error has actually been committed, not merely by men of words, like Addison, Paley, and Whewell,—which is surely sad enough,—but even by a man of things, like Sir Humphry Davy. The great chemist attempts to show that man does not use his limbs instinctively like other animals. Says he:—

"Man is so constituted that his muscles acquire their power by habit,† but in the colt and the chicken the limbs are formed with the power of motion, and these animals walk as soon as they have quitted the womb or the egg.

* Lessons from Nature.

† To speak of acquiring a power by habit is scarcely rational. The power must exist before the habit can be formed.

"*Physicus*.—I think I have observed that birds learn to fly and acquire the use of their wings by continued efforts in the same manner as a child does that of his limbs.

"*Ornither*.—I cannot agree with you. Young birds cannot fly as soon as they are hatched, because they have no wing-feathers; but as soon as these are developed, and even before they are perfectly strong, they use their wings, fly, and quit the nest without any education from their parents."*

Very similar assertions are found in a laborious attempt made by the late Prof. Whewell† to set aside the palpable fact that man, like every other animal, has an instinctive—or we might perhaps better say a hereditary—knowledge of the functions of his voluntary organs.

Said the Professor:—"The child learns to distinguish forms and positions by a repeated and incessant use of his hands and eyes: he learns to walk, to run, and to leap by slow and laborious degrees; he distinguishes one man from another and one animal from another only after repeated mistakes. Nor can we conceive this to be otherwise. How should the child know at once what muscles he is to exert that he may stand and not fall, till he has often tried? How should he learn to direct his attention to the differences of different faces and persons till he is roused by some memory or hope which implies memory? It seems to me as if the sensations could not, without considerable practice, be rightly referred to ideas of space, force, resemblance, and the like. Yet that which thus appears impossible is, in fact, done by animals. The lamb, almost immediately after its birth, follows its mother, accommodating the action of its muscles to the form of the ground. The chick just emerged from the shell picks up a minute insect, directing its beak with the greatest accuracy. Even the human infant seeks the breast and exerts its muscfes in sucking almost as soon as it is born."

So, after all, "that which thus appears impossible" is, in fact, done not by "animals" only, but by man also! The concession contained in the last sentence is simply fatal to what has gone before. To be consistent the learned Professor ought by all means to have asserted that infants learn to suck only "by slow and laborious degrees," and after its sensations have been rightly referred to appropriate "ideas." It would scarcely be a more unwarrantable assumption than

* Collected Works. Vol. ix. Salmonia, p. 105.
† Philosophy of the Inductive Sciences, ii., p. 616.

those he has indulged in abundantly in the course of his argument.

In the same vein as Davy and Whewell, teleologists and natural theologians, when enlarging upon the marvels of instinct, have seldom failed to "trot out" the colt, the calf, or the lamb, to invite our consideration to the chickens and the "young ducks," and to erect upon the precocity of these creatures—as compared with the tedious development of our own species—a fancied wall of demarcation between man and beast. Had they been really actuated by a scientific spirit they would have felt it their bounden duty to ascertain whether *all* the lower animals were, in contrast to man, able to use their limbs soon after their birth. Had they done so they might have met with evidence similar to what is thus given by an actual observer* in describing an infant orang-utan which had come into his possession:—"The Mias like a very young baby, lying on its back quite helpless, rolling lazily from side to side, stretching out its hands into the air, wishing to grasp something, but hardly able to guide its fingers to any definite object, and when dissatisfied opening wide its almost toothless mouth, and expressing its wants by an almost infantile scream. . . . When I had had it for about a month it began to exhibit some signs of learning to run alone. When laid upon the floor it would push itself along by its legs, or roll over, and thus make an unwieldy progression. When lying in the box it would lift itself up to the edge into almost an erect position, and once or twice succeeded in tumbling over."

Thus we see that the nearer brutes approach to man in their structure the more gradual is their development. The process which in the colt and the lamb is contracted so as to escape observation is here shown at very considerable length. That the child, especially in the higher races of mankind, makes a still more gradual progress, is plainly a mere question of degree.

The young ape which Mr. Wallace observed was, beyond all reasonable dispute, acquiring the use of its limbs precisely in the same manner as a human child. If the latter learns, by slow and laborious degrees, what muscles he must exert in order to effect any desired movement, so does the young ape. If the child cannot judge of the position and distance of objects till it has by considerable practice learnt to refer its sensations to appropriate "ideas," the same must be said of the young Mias. But if the young

* A. R. Wallace, Malay Archipelago, p. 45.

apes, and indeed all other young animals, inherit from their forefathers a latent knowledge of the use of their organs, which is called into activity as soon as their muscular and nervous systems are sufficiently developed, the same holds good of the human infant.

Of course it would be unfair to demand of such men as Prof. Whewell that before theorising and dogmatising they should go forth to the forests of Borneo in search of facts. As for Davy, his splendid achievements in chemistry may cover his failure in biology. But surely every man in Europe, though he may never have met with infant apes, must have seen how kittens, when beginning to walk, totter, stagger, and roll over just like young children; how they pat at, and endeavour to touch, objects beyond their reach; and how, even after the fore legs have gained a considerable degree of firmness and obey volition, the hinder extremities remain feeble, and are often for a time trailed helplessly along. Thus, then, we see that in the Mammalia, instead of man standing alone, sharply contrasted to the rest of the class, he merely occupies one extremity of a series towards the other end of which stand our much-talked-of friends the lamb and the foal, whilst the carnivorous animals and the apes occupy intermediate positions. Some very plain reasons why this should be the case will follow in due course.

But what are the facts concerning birds? Are they all able, as soon as hatched, to direct the beak with perfect accuracy, to select suitable nourishment, and to flutter about awaiting merely the growth of their wing-feathers before they can take flight? Davy's "Ornither" must have been either a wilful sophist or a most egregious goose. Had he been an accurate and conscientious observer he must have been aware that what he predicates of birds in general is true, in any sense, merely of the Gallinæ, Grallæ, Anseres, and Struthiones, and assuredly not of the Passeres, Picariæ, Columbæ, Psittaci, and Raptores. Did any of the authors to whom we have been referring, before indulging in platitudes on young ducks, ever take the trouble to "consider" young hawks, young thrushes, or young canaries? Had they done so they would have seen that such nestlings, instead of being able to "direct the beak with the greatest accuracy," can merely sit in the nest with open mouth waiting to be fed! A young canary, so far from being able to stand or walk, seldom fails to break its legs if startled and induced by fright to attempt leaving the nest. Such facts as these are known to every bird-fancier,—nay, we

might say to every rustic youth who has ever robbed a nest and has attempted to bring up the callow young by hand. They are not known, it appears, to men of erudition. It was, we think, the Prime Minister of Gustavus Adolphus, of Sweden, who said to his son—"Thou knowest not with how little wisdom the world is governed." In like manner, and with even more truth, it might be said that we know not with how little accurate thorough knowledge books are compiled, the world is misinstructed, and imposing reputations are built up.

We do not demand original observation from Professor Whewell. Everyone knows that the possessors of inherited wealth are apt to despise the man who has acquired a fortune by his own exertions. But there is a class of men—more numerous we fear in England than in any other civilised country—who, with a still more unjustifiable prejudice, contemn all knowledge that has not been derived from book, and scorn original research and discovery. Still it is strange that none of these writers should have met with the following observation from Gilbert White:*—"On the fifth of July, 1775, I again untiled part of the roof over the nest of a swift. The squab young we brought down and placed upon the grass-plot, where they tumbled about and were as helpless as a new-born child. When we contemplated their naked bodies, their unwieldy, disproportionate abdomina, and their heads too heavy for their necks to support, we could not but marvel."

Davy and Whewell might, further, have found in Erasmus Darwin's "Zoonomia"† some remarks on the different stages of maturity which animals of different species have reached when they are first brought into the world. The author uses these very words:—"The chicks of the pheasant and the partridge have more perfect plumage, more perfect eyes, and greater aptitude for walking, than the callow nestlings of the dove or the wren. It is only necessary to show the first their food and teach them how to pick, whilst the latter for days obtrude a gaping mouth." Would it have been too much trouble for a man of such extensive reading as Prof. Whewell to have run his eyes over the passage above quoted? Being, moreover, a German scholar,—at least to the extent of an occasional mistranslation from the language,—the Professor might have read that Lorenz Oken divided the class Birds into two main subdivisions, nest-

* Natural History of Selborne. Letter XXI.
† Vol. i., pp. 187—194.

sitters and nest-quitters (*nest-hocker und nest-flüchter*), according as when hatched they remain helpless in the nest or are at once able to run about and seek food for themselves.

Davy, by the mouth of "Ornither," gives a very lame explanation of the fact that the majority of birds cannot fly as soon as hatched. Before they can take flight they have to await not alone the growth of their wing-feathers, but the simultaneous development of the muscles. The Raptores, Passeres, &c., are, as we have already seen, unable to walk as well as to fly. Does this inability depend upon the want of feathers? The fact that parent birds educate their young is clearly established by the interesting observations of Dr. C. Abbott.*

In the case of birds of prey the process of education is somewhat prolonged, even after leaving the nest. It is thought by many that Deuteronomy xxxii., v. 11, is a description of the manner in which eagles train their young to fly; "stirring up" the nest, *i.e.*, shaking and disturbing it so as to compel the nestlings to leave their cradle; "fluttering" over them and "bearing them on her wings," —that is to say, following and intercepting their downward movement, and aiding them to re-ascend.

Thus we see that the condition of the young of the lower animals is after all analogous to that of the human infant. The child, indeed, is still slower in learning to walk than the kitten or the young ape, not because he has to learn in a different manner, but because the development of his muscles and joints is much more gradual; because his head is relatively heavier; because he has to support himself on one pair of limbs only, thus rendering his base much narrower and his centre of gravity higher from the ground; and because, as we have already pointed out in the case of the kitten, the hinder extremities gain strength more slowly than the anterior.

Surely, therefore, the helplessness of the human infant can no longer be regarded as an exceptional phenomenon, and all conclusions based upon it by rhetoricians may be safely dismissed to dream-land, whence they came.

* Quarterly Journal of Science, vol. vi., p. 361.

ON WATER AND AIR.*

By JOHN TYNDALL, D.C.L., LL.D., F.R.S.,

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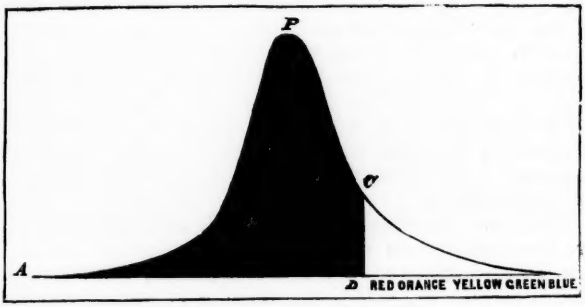
LECTURE IV.

IN our last Lecture I tried to explain to you that the rays of the sun that are really influential in producing evaporation are rays which are entirely incompetent to excite vision. They are what are called invisible rays, and, lest I should have been misunderstood, I think I will dwell for a moment upon this point of visible and invisible rays. I will take here, as I have already done, a slice of white light, and you shall see it, in the first instance, upon the screen. There it is; and now we turn this beam aside and send it through a body which we call a prism. That will separate the different colours of that white light the one from the other, and you will have upon the screen that beautiful exhibition that we call the spectrum. There it is. Now I will add another prism to this single one, and in that way I hope to get, as we have formerly done, a larger spectrum. [A second prism was introduced.] Here, then, is this beautiful display of colour produced by a slice of ordinary white light. Now, I want you to understand that all these lovely colours emanate from this thing that I have called our little "domestic sun," the so-called electric light. Now, suppose that I were not gifted with the sense of vision, but suppose me to be gifted with an extreme sensitiveness as regards heat; then I might walk through that spectrum, and report to you what I should experience supposing myself to be a blind man. I will simply walk through, beginning at this dark portion of the spectrum [adjacent to the red],—or, at least, beyond the spectrum altogether. Supposing my sense of warmth to be exceedingly delicate, I should say to you that I am now receiving a very powerful amount of heat from that electric lamp. You do not see

* Being a Course of Six Lectures adapted to a Juvenile Auditory, delivered at the Royal Institution of Great Britain, Christmas, 1879. Specially reported for "The Journal of Science."

the rays, but the heat falls there far beyond the red. A greater amount of heat falls there than falls in any part of the visible spectrum which you see before you. Let me suppose that I commence here at this distance. I should feel a certain amount of warmth here. I come along; the warmth augments. I come farther along, and the warmth is greater still. In this position I should have the maximum amount of warmth falling upon my face. Then, as I pass on, I come to the visible portions of the spectrum,

FIG. 24.



and I find that I am less warm here. I pass into this brilliant red colour, and I still find a less amount of heat falling upon me. I go on through the entire spectrum in this way until I reach the extreme blue end, and a gradually decreasing amount of heat falls upon my face. I go even beyond this extreme blue end of the spectrum into the dark space beyond it, and allow rays which have no power at all to excite vision to fall upon my face, and yet I should be able to report to you that far beyond the visible eye a gradually decreasing warmth was falling upon my face. Thus to a blind man this whole range of radiant power would represent itself as heat. Of this vast range along which I have gone, the eye, that wondrous organ, selects a little space as available for vision: but beyond this space we have, in both directions, a vast amount of radiation, and so strong are the radiations in the invisible portion that those radiations beyond the red end have about seven or eight times the radiant power of the whole of the visible spectrum. In this diagram (Fig. 24) the area of that dark mountain (C P) represents the power of the invisible radiation to which I have referred. The other portion of the diagram represents

the power of the visible spectrum; so that you have invisible rays equal to between seven and eight times the visible in point of energy.

In our last lecture I tried in your presence to separate one class of rays from the other. Here is a very beautiful clear liquid, called bisulphide of carbon. Here is an element called iodine. You see it here in the form of crystals. If I pour some bisulphide of carbon into this glass cell, and drop into it some of our crystals of iodine, you will see that the liquid instantly becomes dark. This is the solution which I used in our last lecture for the purpose of cutting off the visible rays and allowing the invisible rays to pass through. The sharpness with which that solution cuts off the light of the spectrum, and allows all that mountain of heat, as I have expressed it, to pass through, is amazing. As I have said, this is the preparation which was used to sift or filter the radiation which was given forth by our little sun, and to enable us to see what could be done by the invisible rays alone.

Well, as I have said, these invisible rays are those which are instrumental in raising the vapour of the ocean into the air and into the region of the clouds. But how is it that this vapour, which on starting is perfectly invisible, becomes cloudy? That you will understand immediately. You saw in our last lecture that, by the application of heat, we were able to convert a visible cloud into invisible vapour; and now I want to show you the effect of the simple expansion of air. The air here, at the lower portions of our atmosphere, has to bear the weight of all the atmosphere above it. The consequence is, that it is compressed or closely compacted together; and when that air ascends, carrying with it a load of aqueous vapour into the upper regions of the atmosphere, the pressure upon it becomes less and less, and the consequence of this is that it expands more and more, and by its expansion it chills itself. The chilling thus produced is competent to cause the invisible vapour which started from the ocean to curdle up as cloud. Let us take, for instance, the plains of Lombardy, in Italy. I have sometimes been there when the heavens overhead were of the deepest blue, and not a cloud was to be seen. I have been there when the wind has blown towards Monte Rosa, in the Alps. You can see the effect splendidly from the top of Milan Cathedral. I have seen the air which passed over the plains of Lombardy without a single trace of cloud; and when it came in contact with the mountain it was tilted up to a higher level and chilled, and the Alps

became covered with cloud, though while the air was passing over the plains of Lombardy it was perfectly clear.

Mr. Cottrell has, by means of a pressure syringe, compressed a quantity of air into this iron box (v, Fig. 25), and

FIG. 25.

I want to show you now that, simply by being allowed to expand, the air in this box will chill itself. You see that when I chill the face of this instrument which is connected with the galvanometer, the red end of the needle goes away from me. The smallest contact with the chilled blade of a knife causes the red end of the needle to move in that way. I will warm the instrument a little, so as to bring the needle on the side which indicates heat. Now, what I want you to understand is this:—Here I have compressed air. At the present moment that air is warmer than the air in this room. I will now cause the air to expand by simply turning the stopcock and allowing it to issue. It will force itself out, and a chilling will be produced. The work done by the air in forcing itself out of this box will cause a chill in the air which forces the first portions of the air out. Thus the last portions of the air will be so chilled that you will find that the red end of the needle will go across zero and up on the other side. [The compressed air was allowed to escape from the iron box, v, and impinge upon the face of the thermo-electric pile, P, connected to a galvanometer.] Although the air when compressed was warm, yet it has become chilled by its own expansion, and has chilled the pile. You see that the needle comes down from the direction of heat, and I have no doubt that it will cross zero and go up considerably upon the other side, proving the chilling

of the air by its own expansion. [The needle followed the course indicated by the lecturer.]

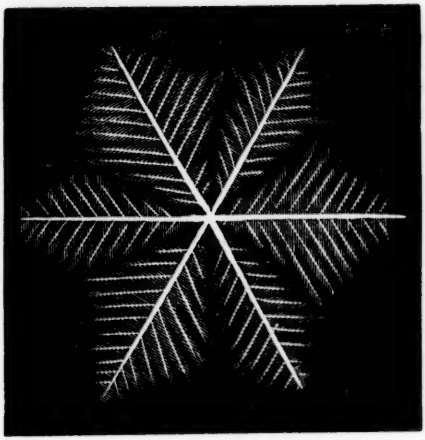
In this glass tube I have a certain quantity of moist air. Mr. Cottrell will now, by means of the air-pump, exhaust this long cylinder of the air which it contains, and then I will ask him to turn on a stopcock so as to allow the moistened air contained in the glass tube to pass into the exhausted cylinder. If I mistake not, the simple expansion of that moistened air by this means will cause a chilling to occur in the glass tube, and that chilling will be sufficient to bring down a visible cloud of moisture. When I tell him he will turn on the cock. Some of the moistened air will rush from the tube into the exhausted cylinder in connection with the air-pump, and will fill that cylinder, and, by virtue of the expansion, the air which is left behind will be chilled exactly like that which was contained in the iron box, and in consequence of that chilling we shall have a cloud precipitated before our eyes. [The experiment was then performed, the interior of the tube being illuminated by the electric light.] There you see a beautiful cloud precipitated the moment he turns the stopcock.

Well, this shows you how clouds can be generated simply by the expansion of the air. When the air ascending up to a higher region is thus expanded, in virtue of the lessening of the pressure upon it, the aqueous vapour contained in the air comes down in this way as cloud. Well, these clouds, of course, descend upon us as rain; but sometimes they descend upon us as snow. The aqueous vapour, when thus condensed in the upper regions of the atmosphere, is not only converted into particles of water, but if the chill be sufficient it is converted into a solid; and nothing can be more beautiful than those crystals of snow which are produced in the air in calm weather, when the aqueous vapour of the atmosphere is congealed. A great many years ago Dr. Scoresby observed the beautiful forms exhibited by the descending snow in the Arctic regions. Mr. Glaisher has also made beautiful drawings of those snow crystals as found in England.

In the winter of 1859 I wished to ascertain the motion of a glacier in mid-winter. I think I was beside the Mer de Glace on the 28th December, 1859, and during a portion of the day heavy snow fell, and I think that in about half an hour my hat was covered for an inch thick with snow. On examining this snow I found every particle of it was found to consist of wonderfully beautiful crystals. I am now going to show you some of these drawings (Fig. 26), but

these cannot be compared in point of beauty with the snow crystals that fell upon my hat at that time. I say that this is a rude and crude form in comparison with the beauty of the crystal itself. I wish you to remember that in all cases the crystalline form is preserved. You always have six of those leaves, and no deviation from that number. You may have deviations in the form of the leaves, but there is no deviation whatever from the six-leaved form. Mr. Cottrell

FIG. 26.



will show you another, and you will find in every case this six-leaved stellar form of the snow. There is no deviation from this rule.

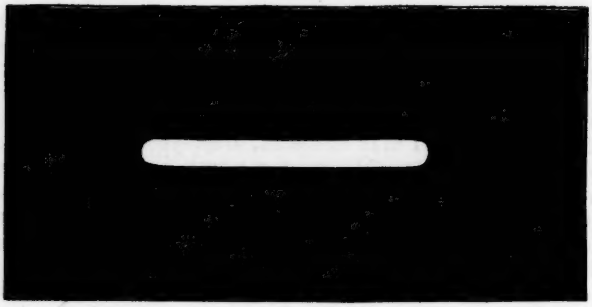
Now I want to try to make clear to you how it is that scientific men explain to themselves this wondrous architectural power, if I may so speak, displayed in the building up of these crystals. We have a number of these crystalline bodies here. For instance, this block is a piece of rock crystal, and here we have a specimen of artificial crystal. Here is a crystal of sulphate of copper, and in the front here you have a mass of alum crystals; and here, thanks to Messrs. Hopkin and Williams, I have a number of artificial crystals. Now I want you to be able to realise the mode in which scientific men represent to their minds how these wonderful crystals are built up. Here I have what every boy or girl is more or less acquainted with, a bar magnet; and here is a magnetic needle. If I hold this magnet thus

in my hand, and draw the magnetic needle towards it, you see that the red end is attracted. There is a certain vivacity of vibration which becomes more and more languid as the centre of the magnet approaches the needle, and directly I come above the centre of the magnet you have the thing reversed. The blue end of the needle is now attracted instead of the red. If I bring the magnet down the needle turns round, and the red end is again attracted. Thus you see that we have one-half of this magnet attracting one end of the needle and the other half attracting the other end, and we have always attraction and repulsion exerted together.

Now I wish to define a term that I have to use with reference to this double force. This simultaneous exertion of attraction and repulsion is what we call "polarity." Magnetism is called a polar force because of this duplex action. In the case of the attraction of gravitation we have nothing of that kind. The sun attracts the planets, and every particle of matter attracts every other particle without the exercise of this double force. The attraction of gravitation is not a polar force. The attraction of magnetism is a polar force.

Now Mr. Cottrell will throw upon the screen the image of a small magnet. There you see it (Fig. 27); and almost every boy has made experiments with iron filings upon magnets. Here we have our magnet, and I will shake some iron filings over it, and we shall see that those iron filings

FIG. 27.



arrange themselves in a certain definite fashion over this magnet. You see how beautiful it is; that is lovely. You see how beautifully they arrange themselves. Every little

particle of iron filings here has two poles, and in virtue of this double polar action they so act upon each other as to arrange themselves in this particular way. We have here an example of the action of what we call a polar force. We see that this polar force is capable of causing these small particles of iron to arrange themselves in definite curves. Now what I want you to understand is this:—Starting from this conception (the notion of a polar force given to those iron filings) the scientific man, who uses the eye of his mind far more than the eye of his body, sees in the power that builds those snow crystals together a kind of polar force. Were it not that in a room so warm as this it is difficult to operate upon ice, I could produce before you those beautiful crystals of water which, as I have said, are so lovely when you see them upon your window-panes on a cold morning. We have been operating upon these crystals, and have produced them in a variety of ways. But instead of water I will operate upon something different. Here we have various kinds of beautiful crystals. This is a crystal of our rock salt that we had in our last lecture; and if you look at this you will see, as in a diamond, planes of shining surfaces. Those planes are the planes of cleavage, and we can cut the crystal parallel to those planes of cleavage and produce these beautiful shining surfaces. This rock salt is cleavable into beautiful cubes; so with the diamond also. It is in the same way cleavable into masses corresponding to its own crystalline form.

I will take a film of liquid, which I trust we shall be able to crystallise. Mr. Cottrell has here some very clean plates of glass, and he will pour upon one of the plates of glass a film of liquid that will be capable of crystallising. We may use water as the liquid in this experiment, but it will be more convenient to experiment with sal-ammoniac, or, as it is called, chloride of ammonium. Mr. Cottrell will pour a film of this liquid upon a glass plate, which he has now in his hand; and he warms the plate for a little while in order to hasten the evaporation. Then he will place the plate in front of a microscope, and he will throw the image upon the screen. Here you see the particles suspended in the liquid, and I have no doubt that when the evaporation has been going on for a time you will find crystals starting through this mass. You will find an illustration of that wonderful architecture, by which the snow crystals are built up. There, you now can see the crystals forming. See how they dart across the field—those wonderful crystalline spears, which are illustrations of this building-power to which I have re-

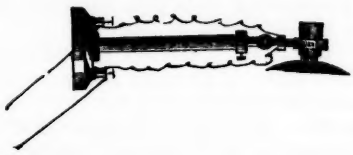
ferred, and which depends, as I have said, upon this polar force exerted by the molecules of matter. We will let the crystallisation go on until it overspreads the entire screen. The crystallisation of water upon the window pane on a frosty morning is quite as beautiful—perhaps more beautiful —than this. This effect is exceedingly good. Mr. Cottrell has given himself great trouble to become master of this. I have rarely seen it better than the exhibition that you have now before you. It is wonderful to see how the crystallisation flashes forth, as it were, by sudden bursts of power, and falls into these beautiful shapes. I will content myself with one more sample of this architectural power exerted by the ultimate particles of matter. Here is a small cell which contains a solution. In our last lecture you saw that by means of our voltaic battery we decomposed water into its two constituent parts, and converted the water into oxygen and hydrogen. I might have collected the separate gases before you in your presence, and shown you that these gases were oxygen and hydrogen. In the same way we shall try to decompose this solution of acetate of lead; and here, instead of the plates of platinum which I employed last time, we have these little rods of platinum wire. They are very clearly shown on the screen. We will now send a voltaic current across this solution in which these two wires are immersed, and you will find that on one of them the lead will be liberated; but, instead of forming a kind of sand heap—a confused mass of the atoms of lead—those atoms of lead, as they are liberated, will build themselves up into most beautiful crystalline ferns.

Mr. Cottrell has now sent the current through the liquid, and he has done so with caution, in order that you may see the growth of those little ferns of lead sprouting from that wire. You have a beautiful growth of lead crystals, thus showing, as I have said, the wonderful architectural power possessed by the atoms of lead when they are liberated. Nothing can be more beautiful than that slow growth. These beautiful fern-like masses resemble a form of vegetation growing in your presence. I will now ask Mr. Cottrell to reverse the direction of the electric current, and you will find these masses disappear, and, on the other side, you will find that the lead will be thrown out first of all in films like a spider's legs. The crystals first formed will melt away, and the ferns will be produced on the opposite pole of the battery. [The current was reversed, and the crystals of lead disappeared from one pole and were formed on the other.]

This force of crystallisation which we have here mani-

fested and illustrated comes into play when water passes from the vaporous condition into the solid condition in our atmosphere; and, not only so, but it comes into play in every mass of ice upon our lakes. There are before you some splendid masses of ice. This is not natural ice, but it is ice which has been artificially produced by the General Ice Factory Company, a company that has instituted itself for the production of this article, ice, in London. Now, I want to show you how it is that these masses of artificial ice are produced. I have never seen such a large block of artificial ice as this before. This ice is produced very cheaply—so cheaply as to compete successfully with the ice which is brought from the lakes of Norway. The cheapness, however, you and I care very little about as regards that about which I now wish to speak to you. Here is a clear liquid called sulphuric ether, and upon the face of this thermo-electric pile I will place the copper basin, B (Fig. 28).

FIG. 28.



I will warm the basin a little so that the red end of the needle, connected to the pile by the wires G, shall come well towards me; and now I pour a little of this sulphuric ether into the copper basin, and I will warm the liquid by simply rubbing it round with my warm fingers. I want you to notice the effect of the evaporation of that ether. It is a very volatile substance, and, when it evaporates, the evaporation is accompanied by the chilling of the ether, so that, although, in the first instance, the needle will rest in its present position upon the side of heat, still, after a little time, in virtue of the evaporation of the ether, which evaporation will infallibly be associated with a chill, the needle will come down, and will pass to the other side. You will see that in this way, by the simple evaporation of the ether, we have produced a very great amount of cold. There, you see that we have got an amount of cold which has carried the needle from where it was down across zero, and far away in the direction of cold. Now, this artificial ice is produced exactly by such means. A mass of ether is caused to surround vessels in which is contained brine, or salt and water.

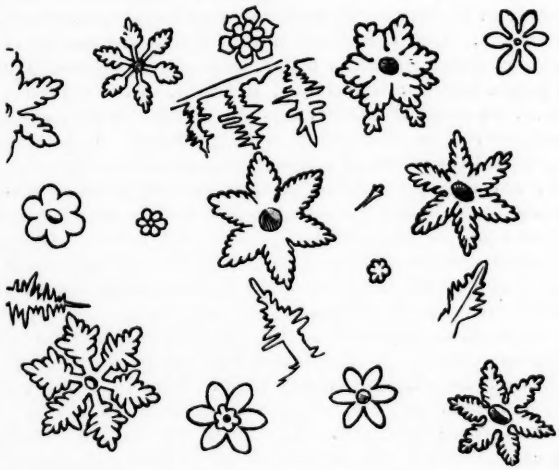
This mixture is chilled by the evaporation of the ether, and the chilled brine is carried round vessels containing water, and then the water is converted into the solid form by the chill produced by the cold brine. And now, not only are those beautiful crystalline forms that you see upon the London pavement, and upon your own windows on a frosty morning, evidences of this wonderful building power possessed by the ultimate particles of matter, but every particle of ice that spreads over the Serpentine, or covers the lakes of Switzerland and Norway at the present moment, is built upon this wondrous plan; and I want, if I can, to dissect in your presence a plate of ice. I see that Mr. Cottrell has got a plate of ice there before you, and I will tell you how it was that this dissection, or analysis, if you like to call it so, occurred. I remember walking through Kensington Gardens, I think, in the year 1858. Many of you were not born then. And I thought to myself, "Ice absorbs or stops a very considerable amount of heat. What becomes of that heat?" I knew that the ice, when once raised to the point when it begins to melt, could not be raised higher in temperature.

You may remember that in our last lecture I placed a plate of rock salt and a plate of glass in the path of our strong beam. The plate of rock salt was not warmed. The plate of glass was heated. And then we inferred from that fact that a certain amount of heat was stopped by the glass, but was not stopped by the rock salt. I asked myself, in walking through Kensington Gardens, "What occurs in the melting of a block of ice when a sunbeam has gone through it?" A good deal of the sunbeam is intercepted: What becomes of it? It cannot warm the ice: then it must liquefy it in some peculiar way within the mass of ice. Well, I got a clear block of ice; and I went into the room through which you passed in coming into this theatre, and the sun was shining brightly: and I placed a lens in the path of the sunbeams, and there I could see, as you have seen over and over again in this room, the track of the sunlight depicted upon the floating dust of the air. I fixed the point where the light was converged, and I put my block of ice so that the focus of the lens should be in the very heart of the ice. Immediately I saw a number of little specks of silvery brightness in the very body of the ice. That did not at all solve the problem I had in hand. I asked myself, "What has become of the heat?" I took up the ice, and looked at it by means of a pocket-lens, and I found that round about each one of these spots I had a most delicate and beautiful little liquid

flower. The heat had expended itself in reducing the ice to the liquid condition—simply in undoing the very work of crystallisation that you have seen exhibited before you on the screen. The particles of ice had been built together upon a certain plan. The sunbeam took those particles or molecules asunder, just reversing the process of crystallisation. And round about those little spots I found a beautiful six-petalled flower of liquid.

And now we will try to show you, in a more or less perfect form, some of those liquid flowers produced by the liquefaction of the ice. We will pass a beam from our electric light through the ice and focus these flowers, as they are formed, upon the screen. Observe those beautiful shapes that are now forming (Fig. 29). Do you see that every one of them has six

FIG. 29.



petals. That is the re-solution of the ice. The ice has stopped a portion of this beam, and that portion of the beam has expended itself in producing these beautiful forms. Some of them are beautifully crimped with fern-like crimpings.

Well, crystals of snow form in this way in calm weather upon Alpine summits, and there they are gathered and collected year after year; and there is a certain elevation where the quantity of snow that falls every year is in excess

of the quantity melted. I had a letter from Switzerland yesterday morning, and at the present time the quantity of snow upon the mountains at Brieg, in the valley of the Rhone, is comparatively small, although the cold is very great. That is an important point to notice. In point of fact, there is not sufficient aqueous vapour in the air to produce snow, however cold the weather may be.

And here let me draw attention, in passing, to a point which has misled many not only eminent, but very illustrious, men. If you go to Switzerland, or even to some parts of England, you find traces of ancient glaciers. If you go to Cumberland, or to Wales, or to the south-west coast of Ireland, you find traces of ancient glacier action which are just as pronounced and clear as the traces of glacier action that are going on to-day in Switzerland. In trying to account for the period in which glaciers extended over nearly the whole of Europe some eminent men have put forth their suppositions. One celebrated notion is that the radiation of the sun, by some means or other, was diminished—that the solar power became diminished, and that, in consequence of the chill, we had the Glacier Epoch. There is also another supposition: it is more than a supposition. It has been thought that the whole of our solar system is moving through space; and it was supposed that, in passing through space, the solar system has passed through spaces which have a very low temperature, and that during its passage through those spaces of low temperature the Glacier Epoch, as it is called, was produced. Now I think that every boy in this assembly will see the defect of this reasoning. At the present moment, as recorded to me yesterday by a letter from Switzerland, the cold is intense, but the quantity of snow which produces glaciers is very little. Why? You are prepared with your answer. The very material of which glaciers are formed is absent. The air is dry, notwithstanding the great cold, and the consequence is that you have very little precipitation of snow, and very little of that nutriment, or of that material, which produces glaciers. I want you to understand that these vast masses of ice which come down the Alpine valleys are entirely due to the congelation of aqueous vapour and its precipitation as snow; so that it is the aqueous vapour which produces the snow. I hope you will see my reasoning. The very agency which gives birth to these large masses of ice which form the glaciers is heat. You could not have those vast masses of ice without having vapour raised from the tropical ocean. This vapour is carried northward; it is congealed in the atmosphere, and

it comes down as snow. The snow becomes compacted together as glaciers, and the whole process is due to the action of heat. Let me try to impress this thing upon your minds still more fully. Take the case of a great glacier near which, I am happy to say, I live for six or eight weeks every year—the great Aletch glacier. I look down upon that mass, all frozen as it is, forming a great river of ice, and I ask myself, What amount of solar heat has been necessary to produce that glacier? Understand me—What amount of solar heat has been necessary to evaporate the water of the ocean so as to produce this glacier? This amount of heat. Suppose a mass of iron five times the weight of that Aletch glacier. Suppose the mass of the glacier quintupled—rendered five times heavier than it is: suppose that mass of iron raised to the fusing-point of cast-iron—white hot. The amount of solar heat which was necessary to produce the present Aletch glacier would be exactly equal to that which would be competent to raise to its fusing-point a mass of iron five times the weight of the glacier—competent to raise the iron to a white heat. Hence you see here what a power the sun exerts in the production of those Alpine glaciers. In point of fact, those who have speculated upon this subject forgot altogether that the case was one of distillation. We had a case of distillation here in our last lecture. I had some salt water boiled, and we condensed the steam from the salt water in another vessel, thus producing sweet water: and that is precisely what is done by the distillation of the ocean. The ocean sends up its aqueous vapour into the air—sweet vapour without any salt. This vapour is again condensed and congealed in the higher regions of the atmosphere, and the process, as I have said, is one of natural distillation. In distillation heat is just as important as cold. You must have the heat to produce the vapour: you must have the cold to act as a condenser. And this is the action of the mountains of Switzerland upon the aqueous vapour of the air.

Observe here this beautiful flask covered with a white coating, which is due to the coagulation of the aqueous vapour of the breath that has come from your lungs. You have been breathing out into this atmosphere and rendering the atmosphere humid. I put a very cold mixture into that flask, and the vapour which came from your lungs has become congealed into hoar-frost on the surface of the flask. And I want to show you that the luminous rays of our domestic sun have no power whatever to melt the hoar-frost. And so it is with regard to the glaciers of the Alps.

The power that melts them is those invisible rays that we referred to in our last lecture.

Now, I also want to show you a peculiar action on the part of water, which is of the utmost consequence in nature. Almost all bodies are expanded upon being heated. Mr. Cottrell has prepared a flask of water, and he intended me to heat it with a spirit lamp, so that you would see the expansion of the water in the tube which goes through the cork of the flask. The water would have expanded, and would have risen in the tube, and you would have seen on the screen the image of the water trickling over the top of the tube. I would have then removed the spirit-lamp which caused the water to expand, and would have surrounded the flask with a freezing mixture. Very soon you would see the water contracting in consequence of the cold. It would gradually contract and go down to a certain point, and then it would cease to contract. Then, if I continued the application of the cold, the water would begin again to expand. Up to a certain point the water would be contracted by cold. Beyond that point, the cold would act exactly as heat would act, and cause expansion; and I intended to lift this column of water by expanding it by means of cold, so that you would see it trickling over the top of the column through the action of cold instead of through the action of heat, as previously. Water contracts until the temperature gets down to about 4° C., or 39° F. That is about 7° above the point where it freezes. That point corresponds to what they call the maximum density of water. Then if you continue the cold, it expands. What does this expansion mean? It is simply a preparation for the act of crystallisation which converts water into ice. At this particular point, 39° F., the molecules, although still in the liquid condition, are beginning to act upon each other, so as to try to build themselves, as it were, into the crystalline form. The crystal of water requires more room than the water itself. When you lower the temperature so as to bring it down to 32° F., at which point water freezes, then the expansion is sudden and so powerful as to rend everything opposed to it. Here is a thick bombshell of cast-iron, for which I am indebted to my friend, Professor Abel. Similar bombshells were filled with water and screwed tightly down, and placed in a freezing mixture in front of the table before the lecture commenced; and those explosions which you have heard during the lecture are, I anticipate, due to the bursting of those bombshells in consequence of the force exerted by the water in passing from the liquid condition into the solid condition.

There is also an iron bottle similar to what used to be operated upon by that glorious old fellow, Faraday. He had these cast-iron bottles made. They are half an inch thick. The bottles were filled with water, and by placing them in a freezing mixture he used to burst those bottles. I think that we shall find that the bombshells and the bottles have been burst. [Upon the vessel containing the freezing mixture being uncovered and searched, it was found that the bombshells and iron bottles had been burst by the freezing of the water contained in them. One of the shells measured $3\frac{3}{4}$ inches in internal diameter, and varied in thickness from three-quarters to seven-eighths of an inch.] This will give you an idea of the irresistible power exerted by the molecules of water in passing from the liquid condition into the solid condition.

ANALYSES OF BOOKS.

The Most Important Articles of Food and Beverages, with their Impurities and Sophistications. A Practical Guide to their Detection.* By OSCAR DIETZSCH, Chemist to the Industrial Museum of Zurich. Zurich: Oscar Füssli and Co.

OF all departments of chemistry that which bears upon public health, and upon the detection of adulterations and impurities in food and in other articles of general consumption, has received in England the largest relative share of attention. Hence we doubt not that medical practitioners, chemists, and even the outside public, will take an interest in a foreign work which in a short time has reached its third edition, and which, as we learn from the Preface, is about to be translated into the English, French, and even the Russian languages. The author, who evidently possesses very extensive experience in this branch of analysis, addresses himself solely to professional men, and does not waste space on the task of teaching outsiders how to perform operations which unless done accurately had much better never be attempted at all.

The first article examined is milk. Here we notice with regret the great weight which the author lays upon the specific gravity of the sample, and consequently upon the use of the lactometer. We had hoped that the arguments against this instrument were so widely known as for ever to deprive it of any higher rank than that of a scientific toy. Dr. Dietzsch points out, however, very judiciously, that statements made concerning the milk of individual cows may have a certain value from a physiological or a pathological point of view, but are utterly useless as regards market-milk, which in these days, in towns at least, is a mixture of the milk of many cows, where individual and exceptional variations are of course lost in the average. If, as is alleged, MM. Vernois and Becquerel, when examining different sorts of market-milk in Paris, found a sample of sp. gr. 1·016, and, without ascertaining anything concerning its origin, analysed it as a genuine milk and inserted the results in their tables, they were guilty of a piece of negligence which cannot be too gravely reprehended.

The author does not give any opinion as to the constancy of

* Die Wichtigsten Nahrungsmittel und Getränke, deren Verunreinigungen und Verfalschungen. Praktischer Wegweiser zu deren Entdeckung.

the "solids minus fat," upon which Prof. Wanklyn and his followers lay much weight. The sophistications of milk customary in Switzerland appear to be substantially the same as those prevalent in England, *i.e.*, removal of the cream and addition of water.

Dr. Dietzsch considers milk-sugar the most constant component of milk, varying merely from 4½ to 5½ per cent. He does not, however, accept the determination of this constituent as a rational process of milk analysis, since it may easily be added to an impoverished milk. As a test for soda and for borax he mixes 100 c.c. of the sample with 0·1 grm. tartaric acid, and applies heat. If the sample does not coagulate, one or the other of these salts is present. An exceedingly valuable feature of this chapter is the account of certain pathological modifications of milk, which are much more to be dreaded than any adulteration. Unfortunately the detection of morbid products in mixed market-milk is exceedingly difficult. Pus is recognised under the microscope as pale, round, faintly-granulated vesicles of different magnitudes, which when touched with acetic acid swell up and lose their granulated surface. We feel tempted to ask whether a spectroscopic examination might not lead to the detection of disease-products in milk?

From milk we pass, by a natural sequence, to water. Here we are somewhat surprised to find English authorities completely ignored. Neither of the rival processes of Professors Frankland and Wanklyn, for the determination of organic and especially nitrogenous matter, is even mentioned. Animal substances are to be detected by the smell of burnt horn given off on the ignition of the dried residue, and approximately determined by the use of potassium permanganate in its most primitive form.

For the detection of ammonia the author Nesslerises the water in its original state. For a quantitative determination he acidulates with hydrochloric acid, concentrates, adds caustic soda, and distils, condensing the fumes in dilute hydrochloric acid. He then evaporates the distillate to dryness in a tared porcelain capsule, and weighs the ammonium chloride thus formed.

On the sophistications of wine the author's views are exceedingly judicious. He considers that nothing should be sold as wine save the liquid produced by the alcoholic fermentation of grape juice without any addition. "Plastering" he condemns, but he is scarcely correct in asserting that this malpractice is chiefly confined to the South of France. It prevails also in Spain, Sicily, even Greece, and has, we regret to say, extended even to Australia. Thousands of bottles of Malaga, he states, are artificially concocted at Cette which never touched the soil of Spain. The artificial colouration of wines, it appears, is defended by merchants on the ground that it is convenient for their customers, the retailers, who can then add water with less fear

of detection. The use of glucose obtained from potatoes he considers most injurious both in compounding wines and in brewing, as a considerable quantity of amylic alcohol is thus introduced into the wine or the beer. Impure glycerin, containing formic and butyric acids, is also injurious. The physiological action even of pure glycerin is far from being accurately known.

As regards vinegar we cannot entirely agree with the author. He is certainly in the right in giving a low rank to malt vinegar, which is absurdly preferred in England; but fruit vinegars—especially the American apple vinegars—retain the delightful aroma of the fresh fruit, and are scarcely inferior to wine vinegars.

The addition of alum to bread is not lawful in England, as the author seems to believe, nor is it quite so common as was the case half a century ago. For its detection he recommends the logwood process.

Upon the "surrogates" of coffee he is deservedly severe. None of them, he remarks, contains either the nitrogenous constituent, caffeine, nor the ethereal oil, nor the tannin. Chicory in particular occasions determination of blood to the head and injures the sight. Our legislature never committed a greater mistake than in sanctioning the sale of coffee mixed with chicory.

It is interesting to learn that the tea imported by way of Russia—the so-called "caravan tea"—is largely mixed with the leaves of *Epilobium angustifolium*.

We should be glad, did space permit, to extend further our survey of this valuable work, with which we hope our public analysts and medical officers of health will before long become acquainted. Its weakest portion, we think, consists of the chapters on milk and on water, and its strongest, perhaps, of those on wine and on beer. The chapter entitled "The Chemical Expert in Court" must be especially commended to the notice of the profession.

A Short History of Natural Science, and of the Progress of Discovery from the time of the Greeks to the Present Day. By Arabella B. Buckley. Second Edition. London: Edward Stanford.

When the first edition of this work made its appearance we could do no other than admit that, notwithstanding certain errors of detail which an industrious critic might here and there discover, the authoress had given a broad, clear, and mainly correct outline of the progress of scientific research and discovery. In

the present edition various omissions have been supplied, as, for instance, the chapter on Sound. Sundry errors have been rectified, and we may now, therefore, more emphatically repeat the recommendation which we gave after examining the former edition.

The work, though mainly intended for children and young persons, may be most advantageously read by many persons of riper age, and may serve to implant in their minds a fuller and clearer conception of "the promises, the achievements, and the claims of Science." The manner in which the theory of Evolution is presented to the reader is admirably judicious. Scrupulous persons who have shrunk from the new Natural History as having an atheistic tendency may here see how utterly groundless were their fears.

A very useful feature of Miss Buckley's work is the bibliographical note placed at the end of each chapter, indicating to the student what books to consult in order to fill up the outline here placed before him.

Lightning Conductors: their History, Nature, and Mode of Application. By RICHARD ANDERSON, F.C.S., F.G.S. London: E. and F. N. Spon.

WE have here a most able and complete monograph, historical, theoretical, and practical, on a subject of great importance, and yet generally neglected. Of course in these days of general enlightenment everyone knows that the lightning-rod was invented by Benjamin Franklin nearly 130 years ago. We can all quote the "eripuit cœlo fulmen," and can point a moral by referring to the opposition encountered by the novel and daring project. But side by side with all this, our paper knowledge, stands the grim fact that in England, at least, from one-half to two-thirds of our public buildings, including churches and chapels, are without any protection against lightning. Of private houses the author considers that not five out of every thousand are fitted with conductors. So rare are they, in fact, that when seen they excite curiosity as a something strange and fantastic. Yet we cannot, in defence of our national apathy, represent the danger from lightning to persons and property as a something infinitesimal and unworthy our notice. Mr. Anderson shows that the deaths from this cause in Great Britain and Ireland average not less than one hundred yearly. Of the damage to live stock, farm premises, and other property, no accurate statistics are attainable, but it is by no means trifling. Still, with a fatalism almost Turkish in its character, we refuse to apply the safeguard

which Science has placed in our hands. We submit to lightning as we do to water-companies, macadamised streets, competitive examinations, chimney-pot hats, and a hundred other constituted nuisances.

Mr. Anderson's work opens with a history of the lightning-rod, or, we might rather say, of the progress of electrical science with especial reference to conductors. That Dr. Franklin's invention met with the opposition usually meted out to all discoveries and inventions, or rather to their originators, is matter of history. None of the various forces usually active on such occasions was here wanting. We trace scientific and academic jealousy, as embodied in the Abbé Nollet; popular ignorance and suspicion displayed by the mob in Geneva, in St. Omer, in Siena, in Padua, and elsewhere. There was ecclesiastical hatred not less shown in Puritan New England than in Catholic Italy; and, lastly, there was royal ill-will in the person of George III. It will scarcely be credited that this monarch was a very acrimonious partisan in a controversy which raged on the question as to whether a lightning rod should terminate in a ball or in a point; that he actually demanded from the Royal Society a formal condemnation of points, and when very justly informed by their president, Sir J. Pringle, that the laws of Nature were not alterable at royal pleasure, he demanded the resignation of the speaker. With this intimation Sir J. Pringle, finding but very lukewarm support on the part of the Fellows, found it necessary to comply. We know no second instance, in any civilised country, of Science being thus formally insulted in the person of her official representative, till we come to the speech delivered in the House of Commons by Acton Smee Ayrton, in justification of his misconduct towards Sir William Hooker.

To return, after this historical survey: Mr. Anderson treats of metals as conductors of electricity, the character of lightning and of thunderstorms, and then enters into the *rationale* of lightning protection. The theory, he shows, is simplicity itself. All that is required is to establish such conduction as to lead away any flash of lightning that may strike the house or other building to be protected, without giving it the opportunity for damage. In other words, the conductor must form the "line of least resistance" between the summit of the building and the ground. But to carry out this principle into practice requires no small amount of skill and judgment. Where these essentials are wanting, as is too often the case, the conductor will be faulty, or may even be worse than none at all. Among the besetting sins of conductors we find it pointed out that the metal may be deficient in thickness; that its continnity may be interrupted; that in obedience to a gross error it may be isolated from the building it is to protect by means of glass supports; that it may not be placed in connection with metallic masses in or upon the building, such as leaden or zinc roofing and gutters, water and gas pipes,

iron balustrades, bells, iron cramps and leadwork used in securing the masonry of spires and pinnacles, safes, machinery, &c. All such objects, the author shows, should be united in one metallic system, so that wherever the lightning may fall it may find a direct path down into the ground. In this last respect, also, too many conductors are faulty. The rods, wire-ropes, &c., often dip merely a few inches into earth which may become dry, and consequently non-conductive. "The earth-connection," Mr. Anderson declares, "is the alpha and omega of lightning protection." Further, a conductor originally perfect may be rendered useless by corrosion, or by damage inflicted by careless workmen. Hence these appliances should be subjected to an occasional inspection, and their conductivity tested by means with which every electrician is well acquainted.

These lessons are enforced by practical examples, in which the damage or destruction of buildings supposed to be protected is explained by some deviation from the principles above laid down.

An interesting feature of the work is a catalogue of public buildings struck by lightning from 1589 to September, 1879, and of twenty-four cases of the explosions of powder magazines from the same cause. One of these, at Brescia, in August, 1769, proved fatal to three thousand persons. There is also a very elaborate bibliography of the subject from Hieronymus Cardanus downwards.

The book is plentifully illustrated, and will prove a most valuable guide to engineers, architects, builders, and to all persons entrusted with the care of public buildings, magazines, shipping, &c.

Proceedings of the Birmingham Philosophical Society. 1878-79. Vol. i., No. 3. Birmingham: Corns, Sheriff, and Rattey.

THIS volume is very much more valuable and satisfactory than the average proceedings of our provincial learned Societies, and Birmingham has fair reason to feel proud of the result. The simple fact is that we find here a very fair proportion of actual sterling scientific work instead of mere words and dreams.

Dr. Norris's paper on the "Development of Mammalian Blood" is exceedingly interesting. He finds that there exist in mammalian blood numerous corpuscles incapable of being seen by the microscope—not from their minuteness, but because they have the same refractive index and colour as the liquor sanguinis in which they float. They are colourless biconcave disks, between which and the red biconcave disks other corpuscles can be detected possessing every gradation of tint. The morpholo-

gical elements of the lymphatic glands and spleen, when examined with the needful precautions, instead of being found identical with the ordinary white blood corpuscles, are found to be disks of the same size as the red corpuscles which are gradually becoming biconcave. As the body which undergoes conversion into the red corpuscle must be regarded as the analogue of the white corpuscle of the ovipara, it follows that in mammals this is the corpuscle of the glands and spleen and their equivalent, the invisible corpuscle of the blood, and not the ordinary white corpuscle as supposed. The latter is probably a mere accidental aggregate of adhesive lymph corpuscles.

Mr. H. W. Crosskey communicates some notes on glacial phenomena in the Vosges Mountains, which are ubiquitous and well characterised.

The Rev. H. W. Watson gives a very fair survey of the researches of Mr. Crookes on molecular motion in rarefied gases.

Dr. Blake's paper on the connection between general and technical education contains many valuable observations, and gives a brief but valuable account of industrial training in Belgium, France, Prussia, and Austria. He rightly sees that the apprenticeship system has had its day, and survives now as a mere nuisance. But the author is strangely mistaken in saying that "a premium is seldom paid, and consequently no one feels it to be his business to look after or to inform the beginner." The very contrary is the fact: premiums are more common now than in the days when apprenticeship was a useful reality, but the money thus paid is in the majority of cases literally obtained under false pretences. The chief danger to be apprehended in all attempts made to give the British workman a higher and more scientific training is that, instead of teaching him to do anything thoroughly, we shall cram him to pass an examination in it.

Under the title "Our Philosophy and our Life," Mr. J. Kenward gives an estimate of the influence of scientific research on prevailing thought and character in England. Whilst admitting the learning, and in some respects the depth of thought, shown in this Essay, we can by no means give it our unqualified approval. The author takes decidedly too rose-coloured a view of the relative position of England in the culture of Science. Our discoverers, indeed, are surpassed by none in the height to which they have risen, but in comparison with those of Germany they are few indeed. Few they must remain so long as we formally discourage original investigation by refusing to accept it as a passport to honours and positions in our universities and museums. Mr. Kenward's survey of the state of Science in England,—which, by the way, contrasts strangely with that given by Dr. G. M. Beard in our February number,—if perused by anyone not conversant with the history of discovery, would lead him to believe that our country can claim the merit of the recent

liquefaction of the permanent gases, as well as of other discoveries to which we have only a very partial right. On the other hand, some of the men who have done us most honour are damned with faint praise on the authority of Gwyn Jefferson! "A reaction of opinion in favour of simple Devolution," we read, "may not be far distant." The precise sense in which the term "Devolution" is to be taken does not appear; but if Mr. Kenward seeks an antithesis to Evolution, surely Revolution is the word to be used—a consideration which we hope will console Prof. Virchow. Much of the Essay touches, if it does not go beyond, the scope of our journalistic competence, and must be handed over to the organs of party politics. To his anti-vivisectionist utterance we must reply that the very definition of cruelty is the infliction of pain and death without a sufficient motive. As regards what Mr. Kenward and some others call the "subjection of women," we must remind him that it is merely a case of differentiation, or, in other words, the division of labour. If any woman, by reason of an exceptional mental character, feels disposed to devote herself to scientific research, we are ready and willing not merely to permit, but to applaud. To foster, however, what seems to us an anomaly, to aim at the formation of whole bodies of *savantes*, seems to us a grave error.

A much more valuable paper is Mr. Lawson Tait's researches on the digestive principles of plants. The author has obtained full proof of the digestive process in *Cephalotus*, *Nepenthes*, the Droseraceæ, and the *Dionœa muscipula*, and confirmed the conclusion drawn by Mr. Darwin from his researches in this direction. He has discovered and examined two substances, to which he gives the names of droserine and azerine. The former of these compounds plays a part resembling that of pepsine in the human stomach. Azerine has also a digestive action, an apparent power of attracting insects, and a singular tendency to absorb moisture from the air. If such papers as this and that of Prof. Norris continue to appear in the "Proceedings of the Birmingham Philosophical Society, they will soon be regarded in the learned world as an authority of no mean rank.

Chapters from the Physical History of the Earth. An Introduction to Geology and Palæontology. By Arthur Nicols, F.G.S. London: C. Kegan Paul and Co.

When we meet with an elementary work on any department of Science which contains no reference to the object of passing examinations, and is not fitted up with strings of questions, we utter an ejaculation of thankfulness, and our heart warms towards the author. Mr. Nicols seeks to prove useful to the

student by presenting him with a comprehensive outline of the earth's history, and also to hold out a helping hand to those who with very inadequate means and opprtunities are striving after self-education. In this endeavour he is by no means unsuccessful. The physical history of the earth, and man's gradual comprehension of its successive phases and of their lessons, is given here clearly, fairly, and judiciously. Minute detail in a volume which does not extend to three hundred pages is of course out of the question.

In a few cases we can scarcely admit the author's views without some limitation. Thus the student may probably rise from the perusal of the introductory chapter with the impression that Aristotle's philosophy was the cause of the so-called "stationary epoch" in the career of Science. We submit it was rather the bad use to which the writings of the Greek sage were put by the learned world of the Middle Ages. Instead of using his observations and conclusions as a starting-point for further research, it took them merely as the basis for debates, discussions, and commentation, and had it possessed Newton's "Principia" or Darwin's "Origin of Species" it would have misapplied them in the same manner. In this respect the learned of the Dark Ages differed, after all, little from us modern Englishmen. We, too, love words rather than things, and we would rather "be examined" in books than test their statements or follow out their indications. Nor are we quite certain that "Science owes much to the Reformation." Protestant theologians have denounced the advances of Science with an energy never surpassed.

In the author's survey of the leading truths of geology and palæontology we notice with pleasure that, whilst he states facts and their interpretations, he is free from rash and presumptuous dogmatism. Where there is room for a difference of opinion he states the evidence on either side, and suspends judgment. Such being the author's disposition, it is the more satisfactory to find that he pronounces for the continuity of life in opposition to the Cuvierian doctrine of successive devastations and re-creations. He shows that a great physical break in the strata is accompanied by a corresponding gap in the succession of organic life, and *vice versa*. He contends that the testimony of the rocks, though often defective, yet in no known instance contradicts the law of continuity. He does not find that palæontology in "an unhealthy region for Darwinism," as Prof. Swallow has recently declared. He admits, further, the vast antiquity of the human race, and he recognises the difficulty of drawing "a scientific boundary" between man and the lower animals.

In short, we must pronounce Mr. Nicols's work, accurate, judicious, and moderate, and can recommend it to both the classes for whom it is designed,—to the student as affording a good oversight of regions which he is about to survey in detail, and to the general reader who merely wishes for a correct summary of the results of geological and palæontological research.

The Story of the Earth and Man. By J. W. Dawson, LL.D., F.R.S., F.G.S. Sixth Edition. London: Hodder and Stoughton.

When a work has, like the one before us, reached its sixth edition, the task of the reviewer is greatly simplified. To give an analysis of the book, to expound the author's views, and to point out what in our judgment is deserving of approval or of censure, is no longer needful. We can merely say that to us it is painful in the extreme to find a man whose abilities are indisputable, and whose services to science we are happy to recognise, so led away as to offer a protracted and disingenuous opposition to the greatest reform in Science which has been effected since the overthrow of the Ptolemean astronomy. How anyone with the remotest claims to candour can still look upon Evolution as opposed to creation is a problem we are unable to solve. No less painful are the personalities directed against opponents. Thus Prof. St. George Mivart, being a Catholic, is encountered in "No Popery" style, almost worthy of Lord George Gordon and his followers. If Darwinism is wholly or in part a mistake, if Evolutionism is altogether a delusion, let this be shown in a scientific manner and by arguments analogous in their spirit to those used when chemical and physical theories are under discussion. Principal Dawson, by his constant appeal to the *odium theologicum*, puts himself completely out of court.

Some Teachings of Development. Being the Substance of the last two of a Series of Twelve Lectures on Animal Development, delivered at the Royal Institution during the months of January, February, and March, 1879. By E. A. Schafer, F.R.S., Fullerian Professor of Physiology. London: H. K. Lewis.

We have here, in the brief compass of three-and-thirty pages, a sound and valuable antidote to the reckless and passionate assertions of such men as Prof. Swallow and Principal J. W. Dawson. The author shows clearly and convincingly that the successive phases in the development of the individual represent similar phases in the process of formation or development of the race to which the individual belongs. Development, therefore, represents descent. The ancestors of every animal have successively exhibited structural conditions which in an abridged form are represented by the successive stages of development of the individual. This, the author justly says, is "the only logical conclusion to which the study of animal development leads."

The misfortune is that we have to deal with men who obstinately keep their eyes closed. They are the rightful heirs of the sages who refused to look through Galileo's telescope, and who, when he performed his celebrated experiment at the leaning tower of Pisa, refused to accept the evidence of their own senses.

The Kansas City Review. Vol. iii., No. 10, February, 1880.

THE principal paper in this issue, "Evolution in Creation," by Prof. G. C. Swallow, is one upon which we cannot congratulate the author. It is fundamentally vitiated by the assumption that Evolution and Creation are antagonistic ideas. Now we hold, as do multitudes of other naturalists, that Evolution is simply the manner in which Creation was effected. That there are Evolutionists who seek to dispense with God is granted. But in like manner there have been, and doubtless still are, believers in the permanence of species who hold that each form of organic life came into existence spontaneously, or else has existed from all eternity.

Results of Observations in Meteorology, Terrestrial Magnetism, &c. Taken at the Melbourne Observatory during the Year 1876, under the Superintence of R. L. J. ELLERY, F.R.S., Government Astronomer. Vol. v. Melbourne: J. Ferres.

THIS volume is a valuable collection of observations, but contains little calling for especial remark. The mean temperature of the air during fourteen years is 57·0° F. for spring, 65·3 for summer, 58·7 for autumn, and 49·2 for winter, the latter figure nearly agreeing with the average for the entire year in England. The yearly mean temperature for Melbourne is 57·6. The highest temperature recorded in the shade is 111·2, and the lowest 27·2. The mean hourly velocity of the wind is 10·5 miles, certainly too much to be pleasant. Fog is not entirely absent. Thus at Wilson's Promontory we find mention of three successive days of "dense, wet, driving fog," and this in the middle of October, which answers to our April.

Studies on the Seat of the Russo-Turkish War of 1877-78.* A Report of Swiss Engineer Officers on their Mission to the Seat of War in 1878, as presented to the Swiss War Department. By C. Ott, Colonel of Engineers. Zürich: Orell Füssli and Co.

We have here a minute criticism of the operations of the contending powers from a purely professional point of view. The author infers that the defence of a country requires fortified central positions, in order that all may not be lost with the fall of external lines of defence, and that a prolonged resistance and a resumption of the offensive may be possible. These chief places of arms serve both for the protection of important towns and for supporting the movements of the army. The chief defence of such positions must lie in detached forts and outworks, the strength of the fortifications be reduced internally. The fundamental idea is the establishment of fortified radii. It is economical, as far as possible, to substitute inanimate masses for living defences,—a view which has its especial signification for Britain, whose armies are relatively small in comparison with its financial resources. Such external detached forts, Col. Ott considers, should be prepared in time of peace. He holds that in case of war the Swiss *Landwehr* would find its proper function in the defence of such entrenched positions.

This work evidently merits the careful attention of military men in England.

A Criticism of Dr. Croll's Molecular Theory of Glacier Motion. By J. J. Harris Teall, M.A., F.G.S. London: Simpkin and Marshall.

The author contends that in his work "Climate and Time" Dr. Croll uses terms—such as conduction, radiation, and molecule—in various senses in which they are not employed by physicists, and "applies the results of physical research, expressed in language in which the terms are used in one definite sense, in support of a theory in the statement of which the same terms are used in a different sense." He contends that the entire theory is based upon an ambiguous use of the word "molecule." Dr. Croll attributes, *e.g.*, to the molecules the property of capillarity.

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* Studien auf dem Kriegs schauplatze des Russisch-Türkischen Krieges.

Elements of Agricultural Chemistry and Geology. By the late Prof. J. F. W. JOHNSTON and Dr. C. A. CAMERON. Tenth Edition. Edinburgh and London: W. Blackwood and Sons.

JOHNSTON'S "Agricultural Chemistry" is so well known, and so deservedly valued by that part of the public who take an especial interest in the first and most important part of the useful arts, that neither an exposition of its nature and contents nor general laudatory phrases can be at all admissible. The present edition has been elaborated by Dr. Cameron in accordance with the discoveries made since the death of Prof. Johnston. The chemical nomenclature has also been altered—a step, in our opinion, of doubtful expediency. Practical men never will speak of sulphuric acid as "dihydric sulphate." We fear that the terminology of "new chemistry" is responsible for no small amount of confusion, and has seriously tended to frustrate the diffusion of a knowledge of chemical facts among the industrial classes.

We are sorry also to find that in our cold, rainy, over-watered climate Dr. Cameron considers irrigation as the best method for disposing of town-sewage, and that too without any previous defecation.

Apart from these drawbacks the work appears entitled to our almost unqualified commendation.

United States Commission on Fish and Fisheries. Part V. Report of the Commissioner for 1877. Washington: Government Printing-Office.

WE have here a goodly volume devoted to an inquiry into the decrease of food-fishes, and to considerations on the propagation of such fish in the waters of the United States. It is well stored with facts interesting both to the ichthyologist and to all practically engaged in the culture and catching of fish. In connection with the carriage of fish from the place of capture to distant markets, we find a very elaborate account of the various contrivances for producing artificial cold. There is also a very complete series of annual reports of the Norwegian fisheries near the Loffoden Islands.

We notice here an interesting essay by Karl Dambeck, on the "Geographical Distribution of the Gadidæ, or Cod Family, in its relation to Fisheries and Commerce."

The manufacture of manure from the refuse of the fisheries appears to be rapidly assuming more extensive proportions on

both sides of the Atlantic. As far back as 1870 the refuse of from 4 to 5 millions codfish was annually worked up into "fish-guano" on the Norwegian coasts, the product containing 8 to 10 per cent of nitrogen and 10 to 15 per cent of phosphoric acid. The manure finds a ready sale in the Scandinavian peninsula, in Germany, and in France.

On looking over the facts and figures contained in this volume —the vast quantity of human food obtained from the sea, together with the supplies of oil, of glue, and of manure—we may well question the economic advantages which certain enthusiastic advocates of "dietetic reform" allege as likely to result from the disuse of animal food.

Victorian Year-Book for 1878-9. By H. HEYLYN HAYTER, Government Statist. Melbourne: Ferris. London: Robertson.

WE have here an elaborate assortment of statistics, vital, financial, agricultural, criminal, moral, religious, and intellectual, the whole enabling us to form a very clear idea of the colony of Victoria as it now is.

Turning to those portions which appeal most to our notice, we are glad to perceive that the Mining Schools of Ballarat and Sandhurst are making good progress, though something remains to be done before they can at all rival, *e.g.*, the Polytechnic School of Zürich. Surely Victoria ought not to be beaten by Switzerland. The Melbourne University will not, we fear, under its present constitution, prove a "researching" body; it is modelled too closely on the English system, even to the extent of granting doctorships of music. It is a pity that Berlin, Bonn, or Jena was not taken as a model.

The agricultural statistics show some unsatisfactory facts. The yield of wine has fallen off by 410,333 gallons, as against 755,000 in 1875. The loss is partly ascribed to the *Phylloxera*, and partly to the introduction of the English sparrow, which here, as well as in the United States, has proved, as any judicious naturalist would expect, a capital blunder.

The cultivation of the olive and the mulberry—the former for oil and the latter for silk—progress but slowly. Australia ought to be one of the greatest producers of wine, raisins, oil, and silk in the whole world. Tomatoes only occupy 3 acres, whilst that nuisance chicory has extended to 155!

The Victorian Review. No 2, December 1, 1879.

We must plead guilty to no small amount of disappointment on examining the goodly number before us. Save a brief account of the results of a journey of exploration in Western Australia, there is not here a single paper which, even if we were desirous, we could discuss in the "Journal of Science." We cannot help expressing our deep regret at finding that the deluge of political agitation which has for some years overspread the home kingdoms, diverting public attention from discovery and from invention, has extended even to Australia.

Urania. A Monthly Journal of Astrology, Meteorology, and Physical Science. Vol. i., January and February.

It may perhaps stagger the British public no little to learn that in this much belauded but somewhat sceptical nineteenth century there is actually a journal published which earnestly, soberly, and with evident sincerity, claims for Astrology the rank of a true Science. Some of us will perhaps feel indignant at the fact, and will begin to reflect whether—according to the new system which regards an appeal to the police-courts as the *ultima ratio* in treating a scientific difficulty—the publication and sale of such a work may not be brought within the provisions of a well-known statute anent "palmistry" and subtle devices. But how many of us in these days could render a reason for rejecting astrology and for pronouncing it in the orthodox manner a mere tissue of imposture and delusion? Let us take the simplest case:—It is asserted that the weather is influenced by the conjunctions of the planets, or by their position in their orbits, a proposition surely which, *à priori*, commands neither our assent nor our dissent. How many of us could meet it by an appeal to facts, and prove from actual and accurate observation that no such influence exists? The fact is that we are too rash alike in our beliefs and disbeliefs. If, however, the writers of "Urania" are not in error, it would surely be easy for them to produce evidence which cannot be gainsaid. A forecast of the weather for the next twelve months, which should be found to agree with facts, will serve their purpose better than any quantity of discussion.

CORRESPONDENCE.

A QUERY FOR PHRENOLOGISTS.

To the Editor of The Journal of Science.

SIR,—I believe it has been said, by an authority no less competent than Professor Owen, that to distinguish between the brain of man and that of the anthropoid apes is the "anatomist's difficulty." On the other hand, it is maintained by phrenologists that the organs of the "moral sentiments," and those sentiments themselves, are wanting in the lower animals. If this assertion is true, there ought to exist a very broad and well-marked distinction between the human and the simian brain. Again, few naturalists of the New School will accept the dogma that the so-called moral sentiments are confined to man. I certainly maintain that the manifestations of benevolence, veneration, and consciousness can be distinctly traced, *e.g.*, in dogs.

As there appear some symptoms of a recrudescence of phrenology, this difficulty, I think, calls for an explanation from its advocates.—I am, &c.,

R. N. M.

ARE WASPS CARNIVOROUS?

To the Editor of the Journal of Science.

SIR,—A correspondent in a contemporary, after stating that in Sutherland he had seen a wasp "in the act of devouring a caterpillar which was still alive, but considerably mangled by the mandibles of a wasp," enquires "Is it not unusual for the common wasp to eat living creatures of any sort?" Had he directed his attention to wasps when in a room he would have seen them chase flies, catch (I cannot say devour), kill, and suck their juices. In Greece there is a wasp which makes a prey of spiders, tracking them as a spaniel will track a hare or a partridge. Dr. Erasmus Darwin ("Zoonomia," vol. i., p. 263) says, "Wasps are said to catch large spiders, and to cut off their

legs, and carry their mutilated bodies to their young.—'Dict. Raison,' tome i., p. 152." Further he says, "One circumstance I shall relate which fell under my own eye, and showed the power of reason in a wasp as it is exercised among men:—A wasp on a gravel-walk had caught a fly nearly as large as himself. Kneeling on the ground, I observed him separate the tail and the head from the body part, to which the wings were attached. He then took the body part in his paws, and rose about 2 feet from the ground with it; but a gentle breeze wafting the wings of the fly turned him round in the air, and he settled again with his prey on the gravel. I then distinctly observed him cut off, with his mouth, first one of the wings and then the other, after which he flew away with it unmolested by the wind."—I am, &c.,

S. B.

[Wasps are not merely carnivorous, but are even guilty of cannibalism. In the summer of 1878, having killed one which persisted in settling upon the stage of our microscope, we were surprised shortly after to see another wasp alight upon the body, make incisions into the thorax and abdomen, and feast upon the juices.—Ed. J. S.]

A CASE OF HEREDITY.

To the Editor of the Journal of Science.

Sir,—As you have from time to time dealt with the question of heredity you may feel an interest in the following facts, which I quote from an American journal of standing:—"Elias Phillips, of Freetown, Mass., who recently appeared as a witness in a burglary trial, having turned State's evidence, is a great-grandson of the notorious criminal Maltone Briggs, who was in prison with seven of his sons at one time. Brigg's ancestry is traced back to a noted pirate in the time of Earl Bellamont, and his family has for over a century furnished notorious criminals in every generation."

Surely such facts can require no comment.—I am, &c.,

A Jurist.

DEVELOPMENT AND DIFFERENTIATION.

To the Editor of the Journal of Science.

SIR,—We generally find that the processes of development and differentiation go hand in hand, the former being scarcely conceivable without the latter. Thus animal species which are scarcely distinguishable when in the embryo state become more and more unlike each other as they come to maturity. But there are some cases which I, at least, feel unable to bring under this rule. Thus there are certain Lepidoptera whose caterpillars are not only as distinct, respectively speaking, as the mature insects, but where the diagnosis of the latter is scarcely possible without reference to the caterpillar. Hence the structure of the larvæ is more and more taken into account in determining and classifying insects.—I am, &c.,

AN ENTOMOLOGIST.

A DIFFICULTY TO SOLVE.

To the Editor of the Journal of Science.

SIR,—Turning over some old notes I came upon the following record of facts, which may perhaps interest some of your readers:—A wealthy landowner was seized with the whim of converting a village upon his estate into a town. Among other steps to this end he erected at one entrance a gateway modelled after those of mediæval fortified cities, with an arch over the road surmounted by several rooms, which I suppose were to represent the dwelling of the warder. It soon became noised abroad that whoever slept in one of these rooms, no matter what might be his constitution or his habits, was, in nine cases out of ten, attacked with nightmare of a very violent kind. I heard all the particulars from a scientific gentleman who had taken much pains to trace the cause of this singular phenomenon, and had passed many nights in the room, but without being able to find the slightest clue.—I am, &c.,

SENEX.

NOTES.

Dr. W. B. Carpenter, F.R.S., in a Lecture delivered at the Royal Institution, January 23rd, maintained, in accordance with Prof. Geikie, that the present Continental ridges have probably always existed in some form, and that the present deep Ocean-basins likewise date from the remotest geological antiquity. He considers it, however, possible that at some period a band of connection may have existed between Europe and America, and that New Zealand, Tasmania, and South America may have been linked together by ridges of dry land, whilst Madagascar may have been joined in a similar manner to the African continent, and even with Asia. He does not consider that there is satisfactory evidence for the supposed continent Atlantic being between Africa and America.

On March 4th Mr. G. J. Romanes, F.R.S., delivered a Lecture in the Glasgow City Hall on "Mental Evolution." He urged that the burden of proof lay with those who maintain that the human mind has not been evolved, but has been produced in an exceptional manner. He considered that the theory of Evolution had nothing to fear and everything to hope from the advance of psychological science.

Mr. E. D. Cope delivered last autumn a most interesting Lecture before the California Academy of Sciences, on the Modern Doctrine of Evolution. Whilst accepting the theory in its widest sense, and admitting Natural Selection as a *vera causa*, he contends that "Selection" and "Survival" do not go to the root of the matter, *i.e.*, the origin of the fittest.

A Mr. T. Warren O'Neill, of the Philadelphia Bar, has published a "Refutation of Darwinism," and meets himself with a neat refutation in the "American Naturalist." The author believes that the present condition of animals is one of degradation from a state of original perfection, which has been brought about by the severity of the struggle for existence. The reviewer shows that this view, be it true or false, leaves the origin of species untouched, whilst palæontology shows no evidence ot that primitive physiological integrity which Mr. O'Neill assumes.

Count d'Ursel, in a recently published work on South America, asserts that in Bolivia, Peru, Chili, La Plata, and Brazil, he has met with an insect which after its death is transformed into a plant. He describes and figures this creature as a thick, hard grub, with distinct articulations. When about to die it buries

itself some centimetres deep in the earth, and there gradually increases in circumference till it presents an appearance very like that of a potato. A stem is then put forth, which in the spring months bears a crop of blue flowers! Without at all impeaching the veracity of the Count, we fear there is here scope for error of observation.

M. le Bon, in a memoir recently crowned by the French Academy of Sciences, shows that the differences in the cranial development of individuals of one and the same race become greater the higher the race rises in the scale of civilisation. Hence, far from tending towards equality, men tend, on the contrary, towards increasing differentiation.

M. Torrès Coicedo, the Ambassador of Salvador, has presented to the Society of Acclimatisation, of Paris, two curious plants, the guaco and the cedron, said to be successfully used in South America as an antidote to the poison of serpents and to that of rabies. In both respects their reputed efficacy requires confirmation.

M. Jousset de Bellesme contends that luminous insects, such as the Lampyridæ, have not a luminous substance stored up, but that their special secretion is consumed as fast as it is produced.

According to MM. Brongniart and Cornu multitudes of insects of the species *Syrphus mellinus* have been destroyed by a microscopic fungus, of the genus *Entomophthora*. M. Pasteur suggests the propriety of experimentation with a view to discover some fungus capable of destroying the *Phylloxera*.

According to Dr. Parrot the right hemisphere of the brain is the earliest developed. Contrary to what holds good in the white race, in the negro the posterior part of the cranium is the earliest to become ossified.

A subsidy of 900 francs allowed the first year of the French Government to the Zoological Society of France has been withdrawn.

Bœttger, in his Monograph of the Reptiles and Batrachians of the South of Portugal, describes twenty-one species, five of which are new to the country and one is entirely new to Science.

Prof. Von Tieghem has shown that *Bacillus amylobacter*, which is now the great agent in the decomposition of cellulose, appears to have exercised the same function in the Carboniferous Age.

According to M. G. Carlet, insects when walking move their feet in the following order:—

1—4
5—2
3—6

Thus always resting on a triangle, formed by the front and hind foot of one side and the middle foot of the opposite side. In the Arachnides, which have four pairs of legs, the order of movement is—

1—5
6—2
3—7
8—4

A species of *Curculio* (*Phylonomus punctatus*) is committing great ravages in the clover-fields of Lombardy.

New enemies of the vine have been recently recognised:—*Phona uvicola* near Narbonne, and *Cladosporum viticolum* and *Peranospora viticola* in North America.

A Biological Curiosity.—I open *the book* at page 184,* and I read:—"On placing a *decapitated* frog at the bottom of a vessel filled with water, the animal rises to the surface and keeps itself there, *with its head in the air*. If the frog is placed in the same vessel, under an inverted jar filled with water, it *behaves in the same manner*."—*Revue Internationales des Sciences Biologiques*, 3e Année, p. 187.

According to Dr. Cohn, Prof. Virchow, and Dr. Almgvist, the colour-sense in uncivilised nations—such as the Nubians, Lapps, and Tschutksches—is very well developed, though they may be deficient in words to express the different shades. This is further proof of the incorrectness of the view put forward by Magnus, Gladstone, and Geiger, that a lack of accurate colour-names indicates the want of accurate colour-perception.

Mr. L. F. Ward ("American Naturalist") contends that hermaphroditism is a thraldom, necessary at the outset, from which all living things are seeking to escape. The animal kingdom has for the most part thrown off this yoke, and the vegetable world looks to insects as its liberators.

E. L. Ellicott, in the same journal, has observed hundreds of snakes (*Eutænia sirtalis*) heaped together in a mass. On another occasion he noticed "a ball of black snakes (*Bascanion constrictor*) rolling slowly down a hill-side."

[We have heard rumours of mass-meetings of snakes taking place in various parts of Eastern Europe; but we had never the good fortune to meet with such a case, and our informants were not the most trustworthy.—Ed. J. S.]

A Strange Psychological Theory.—At the last Congress of German Naturalists and Physicians a certain Prof. Jäger, amidst the laughter of the assembly, propounded the theory that the

* H. Milne-Edwards, Leçons sur la Physiologie et l'Anatomie, comparée de l'Homme et des Animaux, vol. xiii., p. 184, line 8.

soul of every man and animal is to be found in the specific odour which each exhales. The Boston "Journal of Chemistry" quotes from the Berlin "Gegenwart" a report of some alleged experiments made by one Dunstmaier to test the accuracy of this hypothesis, and which gave an affirmative result, even to the isolation of such principles as timidity and courage dissolved in glycerin.

Hereditary Effects of Extirpation of the Spleen.—According to "Medicinische Neuigkeiten," Dr. Masoire is engaged with a series of experiments upon rabbits for the purpose of testing this question. Already the weight of the spleen in the offspring of the animals operated upon has been reduced to one-half. The experimentalist hopes to ascertain not merely the functions of the spleen, but to trace in how far the removal of an organ during a series of generations may affect its development.

Prof. Huxley, on behalf of Baron Ettinghausen, communicated to the Royal Society a valuable report on the Fossil Flora of Alum Bay. He has recognised at least 116 genera and 274 species, distributed into 63 families. Many of the forms indicate that the climate was at least subtropical. The number of palms, however, is small as compared with those found in the Sheppey deposits. Many of the species form connecting-links uniting characters which have in later epochs become separated. There are indications that certain Miocene genera had not become differentiated in the Eocene period. Thus *Castanea*, perfectly developed in the Miocene, seems to be represented in the Eocene by a *Castanea*-like oak, *Quercus Bournensis*, which combines in itself the characters of both genera, now no longer found united. More than fifty of the Alum Bay species are common to Sotzka and Haering, whilst a lesser number are common to Sézanna, the Lignitic of America, and to other Floras.

Dr. W. H. Gaskell communicates to the Royal Society an account of researches on the "Tonicity of the Heart and Arteries." He finds that the heart, like the arteries, possesses what may be called tonicity, the variations in which play an important part in determining the features of the cardiac beat. The tonic condition is probably due to the alkalinity of the blood, as it is lowered by dilute acid solutions.

Dr. C. William Siemens, F.R.S., has communicated to the Royal Society an account of some most interesting investigations on the Action of the Electric Light upon Vegetation. His experiments lead to the following conclusions: that electric light is efficacious in producing chlorophyll in the leaves of plants, and in promoting growth; that an electric centre of light equal to 1400 candles, placed at a distance of 6½ feet from growing plants, appeared to be equal in effect to average daylight at this season of the year, but that more economical effects can be

attained by more powerful light centres; that the carbonic acid and nitrogenous compounds generated in the electric arc produce no sensibly deleterious effects upon plants enclosed in the same space; that plants do not appear to require a period of rest during the twenty-four hours of the day, but make increased and vigorous progress if subjected during daytime to sunlight and during the night to electric light; that the radiation of heat from powerful electric arcs can be made available to counteract the effect of night frost, and is likely to promote the setting and ripening of fruit in the open air; that while under the inflence of electric light, plants can sustain increased stove heat without collapsing, a circumstance favourable to forcing by electric light; that the expense of electro-horticulture depends mainly upon the cost of mechanical energy, and is very moderate where natural sources of such energy, such as waterfalls, can be made available. Dr. Siemens has since learned from the observations of Dr. Scübeler, of Christiana, on the effects of uninterrupted sunlight during the long summer days of the Arctic, that plants under the influence of continuous light not merely grow rapidly, but develop more brilliant flowers and larger and more aromatic fruit than under the alternate influence of light and darkness. The formation of sugar depends chiefly upon temperature. Dr. Siemens mentions the interesting fact that the human skin is blistered by the action of the electric light, though without any sensation of excessive heat—an effect analogous to that produced in a clear atmosphere of the sun's rays.

We beg to call the attention of our readers to the arrangements of the Royal Institution for the second quarter of the year. When we state that Prof. Huxley is announced to lecture on the "Coming of Age of 'the Origin of Species,'" Prof. Tyndall on "Light," and Mr. G. H. Romanes on "Mental Evolution," no one can doubt that the Council have provided for the members, subscribers, and their friends an intellectual treat of no mean order.

Two of our weekly contemporaries propose a conference of curators and other officials of museums. Whilst warmly approving of the suggestion, we hope that the curators, should they meet, will not fail to protest against the present regulations concerning admission into their honourable body.

The "Medical Press" describes and figures a suction instrument for poisoned wounds, which may prove very useful in case of the bites of serpents, rabid dogs, &c. As it is now well known that the poison, *e.g.*, of the cobra is dangerous if it comes in contact with a mucous membrane, suction with the lips in such cases cannot be recommended.

We learn that a mischievous propensity is springing up among local sanitary authorities to remunerate their medical officer of

health merely by fees for being called in "when the authority sees fit"—which may be never. Those who have not forgotten the lamentable circumstances which led to the resignation of Dr. C. Fox will see reason for vigilance lest the medical officers of health should be reduced to mere nonentities in favour of persons interested in the conservation of nuisance.

Prof. Roscoe has recently exhibited some specimens of finely divided gold, prepared by Faraday, proving that metallic gold may exist in two distinct molecular conditions.

Prof. Metschnikoft proposes a new method of dealing with noxious insects. The application of yeast to shrubs and plants thus affected has often proved successful, and is recommended by Prof. Hagen, of Cambridge, Mass. But according to Prof. Metschnikoff (see "Zoolog. Anzeiger," No. 47) the action of yeast, when successful, is due to the accidental presence in it of the fungus known as "green muscardine" (*Isaria destructor*), which are exceedingly deadly to insects. He has succeeded in cultivating the muscardine, and hopes that by its means the *Phylloxera*, the Colorado beetle, &c., may be eradicated. It is to be hoped that the new power we are thus invoking may prove amenable to control, or perhaps the remedy may prove worse than the disease. What if this fungus prove deadly to the silk-worm, the honey-bee, and, worse still, to those species—chiefly Hymenopterous—which effect the fertilisation of flowers?

According to the "Kansas City Review" remains of gigantic race of men, considerably advanced in civilisation, have been discovered "in a cave on the old Smith farm in Tiffin Township, Adams County, Ohio." The cavern had at one time been a burial-place, and contained many tombs adorned with bas-reliefs of a very high artistic character. One of the tombs, when broken open, was found to contain the mummy of a man 9 feet 1 inch in length. Several tools and weapons of copper were found in the tomb, hardened to such a degree that a file will barely scratch the lance. It is to be hoped that further examinations will be undertaken by fully qualified persons. Perhaps at last a light will be thrown on the early history of the western hemisphere.

The same Review mentions, on the authority of Dr. F. A. Ballard, that in Jackson County, Missouri, has been found the tusk of a mastodon over 14 inches in diameter and 12 feet in length.

The "Leadville Herald" announces the discovery of a true glacier in the Mosquito Range of the Rocky Mountains.

In a memoir on magnetic circuits in dynamo- and magneto-electric machines, communicated to the Royal Society by Lord Elphinstone and C. W. Vincent, it is shown that any interference with the lines of force about a magnetic circuit means an inter-

ference with the magnetic circuit itself, and points to the possibility of building up magnetic force of magnets by the mere movement of wires in these lines of force, though the coils moved need not of necessity be connected with the helices surrounding the magnets.

Mr. F. Geddes has laid before the Royal Society a paper on the coalescence of amœboid cells into plasmodia, and on the so-called coagulation of invertebrate fluids. The author considers it may be safely asserted that all the evidence we possess points to the conclusion that the power of coalescing with its fellows, under favourable circumstances, to form a plasmodium, is at any rate a very widely spread—if not a general—property of the amœboid cell.

Dr. MacMunn, according to a memoir communicated to the Royal Society, has succeeded in isolating urobilin from urine, and determining some of its principal optical and chemical properties. It is an amorphous, nitrogenous, brownish red pigment, derived from one of the colouring-matters of bile.

Dr. Thudichum has laid before the Royal Society a paper on the modifications of the spectrum of potassium effected by the presence of phosphoric acid, and on inorganic salts and bases found in combination with educts of the brain. He combats the evidence recently advanced by Prof. E. Roscoe in favour of the existence of "protagon" as a definite chemical compound. He also points out errors in the determination of inorganic matter in the brain, and in organic bodies generally.

M. E. A. Schäfer, F.R.S., communicates to the Royal Society the results of an elaborate investigation of the immature ovarian ovum in the common fowl and in the rabbit, with observations on the mode of formation of the discus proligerus in the rabbit and of the ovarial glands in the dog.

According to the researches of C. DeCandolle and Raoul Pictet the seeds of plants lose little of their germinating power even by prolonged exposure to intense cold. The refrigeration was carried down to $-80°$.

ERRATA.

Page 168, line 3, *for* "acceptable" *read* "accessible."
„ line 25, *for* "Drydale" *read* "Drysdale."